TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Morice Timber Supply Area Analysis Report

February 2002

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Morice Timber Supply Area Analysis Report

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Preface

This report contains a timber supply analysis and socio-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia.

To determine allowable timber harvesting levels, the chief forester must have an up-to-date assessment of the timber supply based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code (FPC) of B.C. Act* and official land-use decisions made by Cabinet.

Focussing the assessment on the implications of current practices rather than looking at a number of different management schemes expedites the analysis process, allowing analysis of all TSAs in the province every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the chief forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the chief forester with some of the information necessary for these considerations.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. (The first two documents are the information report and the data package). A fourth document called the public discussion paper will summarize the technical information and will provide a focus for public discussions of possible timber harvest levels. The fifth will outline the chief forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Morice Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the short (next 20 years), medium (21 years to 100 years from the present) and long (beyond 100 years from the present) terms. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. **It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Morice Timber Supply Area (TSA) covers approximately 1.5 million hectares on the western edge of British Columbia's central Interior Plateau. It is bordered on the west by the Kalum and Bulkley TSAs, on the south by Tweedsmuir Provincial Park, on the north by the Fort St. James Forest District and on the east by the Lakes TSA. About 64% of the Morice TSA (approximately 961 000 hectares) is considered productive forest area managed by the Crown. Currently about 71% of the productive forest, or 46% of the total TSA, is considered available for timber harvesting under current forest management practices. These practices follow the standards and legislation set out by the *Forest Practices Code* and the agreements made under the Morice Local Resource Use Plans (LRUP). Within the area available for timber harvesting, most of the forests are dominated by lodgepole pine and to a lesser extent, spruce and balsam species.

The results of this timber supply analysis suggest that harvest levels can be maintained at the current AAC for the Morice TSA (1 961 117 cubic metres per year, which excludes the woodlot licences issued since the last determination) for the next 40 years without creating future timber disruptions, if followed by an 8.2% drop to a mid- and long-term harvest level of 1 803 000 cubic metres per year.

These results reflect current knowledge and information on forest inventory, growth, and management. However, uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses showed that these uncertainties could affect timber supply to varying degrees.

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the harvest forecast relies on harvests from these stands for the next 100 years. The largest potential effects on projected harvests over the short term are associated with uncertainties in estimates of timber volumes in existing stands, increases in the length of time taken to achieve green-up, reduced maximum allowable disturbance in the integrated resource management areas and increased bark beetle activity.

Medium-term (21 to 100 years from now) timber supply is affected by many of the factors tested through sensitivity analysis. Because the harvest forecast is fairly flat over the entire forecast horizon, (one 8.2% drop in decade 5), changes in factors that alter either the total amount of existing volume, or the ability to access existing and managed stand volume during the first 100 years will affect medium-term timber supply. The medium term is affected by changes in the size of the timber harvesting land base; volumes from existing stands; volumes from managed stands; green-up requirements; allowable visual disturbance; stand and landscape-level biodiversity; site productivity estimates; bark beetle activity; regeneration density; rules governing which stands are selected for harvesting and; the standards used to define merchantable trees.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changes to existing stand volumes.

In conclusion, this analysis indicates that based on current inventory, growth and yield, and forest management information, timber harvests in the Morice TSA can be maintained at the current level for 40 years. The analysis indicates that several factors related to the current forest inventory, forest cover requirements and management regimes could affect timber supply along with increased bark beetle activity. However, other than the possibility that site index may be underestimated in older spruce and balsam stands, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis.

Executive Summary

The socio-economic analysis for the Morice TSA indicates that the base case forecast of 1 961 117 cubic metres could support a total of approximately 1,020 person-years of direct forestry employment. Direct forestry activity in the TSA would support a further 310 person-years of indirect and induced employment across the province. The base case forecast, if fully harvested, could provide the provincial government with average revenues of about $112 million per year.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked, the financial profitability of harvest operations depends upon the terrain, as well as on the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect other forest values, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood. Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the chief forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.

Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.
Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The B.C. Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models* to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Morice TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Timber supply analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. This is followed by summary and conclusions for the timber supply analysis in Section 6. Section 7 shows results of a socio-economic analysis for the Morice TSA. Appendixes A and B contain further details about the data and assumptions used in the analysis.

As part of the timber supply review (TSR), information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis provides information for the chief forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Morice TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by assessing employment and income implications of the timber harvesting levels projected in the base case.

The analysis includes estimates of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands-related, processing, and silviculture. Employment is measured in person-years*. Employment income is calculated using average industry income estimates.

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Forest Inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Introduction

Indirect and induced employment figures were calculated using the Morice TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions* and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

1 Description of the Morice Timber Supply Area

The Morice Timber Supply Area (TSA) is situated on the western edge of British Columbia's central Interior Plateau and covers approximately 1.5 million hectares. The TSA is bordered on the west by the Kalum and Bulkley TSAs, on the south by Tweedsmuir Provincial Park, on the north by the Fort St. James Forest District, and on the east by the Lakes TSA. The borders of the Morice TSA correspond with those of the Morice Forest District, one of six districts in the Prince Rupert Forest Region. The TSA is administered by the forest district office in Houston.

The population of the Morice TSA is about 5,500 according to the 1996 census, a 9% decrease since 1991. The main community is Houston, which is home to about three-quarters of the TSA population. The remainder of the population lives in smaller communities such as Topley and Granisle, or on the many ranches and farms along the Highway 16 corridor and in the area from Owen Lake to Francois Lake.

The Morice TSA lies along the western edge of B.C.'s Interior Plateau, with the Cascade Mountains to the west. Extending from the most northerly tip of Babine Lake in the north to Ootsa and Whitesail lakes in the south, the TSA has a gentle, rolling landscape in the north and east, becoming more mountainous in the southwest. Major rivers include the Bulkley, Morice and Nadina. The overall climate is transitional between coast and interior, with cool summers and cold winters.

The forests of the Morice TSA are fairly diverse. However, within the land base currently considered available for timber harvesting, lodgepole pine is the dominant species occupying more than 50% of the land base. The two other major species are hybrid spruce and subalpine fir (balsam). Trembling aspen, amabilis fir, western hemlock and mountain hemlock also occur in minor amounts. Over 60% of the forests in the TSA are currently mature and old; over time the forest will consist more predominantly of younger stands (less than 120 years) as a result of harvesting.

The current allowable annual cut (AAC) in the Morice TSA is 1 985 815 million cubic metres. This level was set by the chief forester in July 1996, and represented a slight decrease from the previous AAC to accommodate new woodlot licences*.

About 64% of the TSA land base is considered productive forest land managed by the B.C. Forest Service (approximately 962 000 hectares). Currently about 71% of this forested land base is considered available for harvesting (46% of the total TSA land base).

Significant changes that influence forest management have occurred since the last timber supply review was completed. These changes include:

- implementation of the *Forest Practices Code (FPC)**;
- revisions to operability* mapping;
- completion of terrain stability mapping, a new recreation inventory and a forest inventory audit;
- interim harvesting guidelines for the Telkwa Caribou Herd Recovery Program Area;
- additions to the existing visual landscape inventory (recommended visual quality objectives) and approval of 'known' scenic areas* for the TSA (but not formal designation of visual quality objectives); and
- mapping of preliminary forest ecosystem networks (FEN)*.

Woodlot licence
An agreement entered into under the Forest Act. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.
Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Forest Ecosystem Network (FEN)
An area that serves to maintain or restore the natural connectivity within an area.

1 Description of the Morice Timber Supply Area

Since the 1980s, most strategic planning for land and resource use in the Morice TSA has been for forest management purposes (e.g., the Morice River and Nadina Local Resource Use Plans). A sub-regional Land and Resource Management Plan (LRMP)* process will start soon, and background work to assess inventories is already underway. The LRMP would recommend objectives and strategies for managing land and resources throughout the TSA. In many areas of B.C. a major role of LRMPs has been to make recommendations on the 10 proposed protected areas* in the Morice TSA as part of the protected areas strategy. In the absence of a completed plan, for the purposes of this timber supply analysis, harvesting in these areas will be deferred for 10 years. In addition, holders of the Morice and Lakes Innovative Forest Practices Agreement (IFPA) are currently developing a Forestry Plan. Once this plan has been approved for the Morice and Lakes TSAs, long-term plans will be developed that consider integrated resource management (IRM)* of forest lands. The IFPA inventory database, public involvement process and interim forestry plan products could provide valuable information for the LRMP planning table.

Land and Resource Management Plan (LRMP)
A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

1 Description of the Morice Timber Supply Area

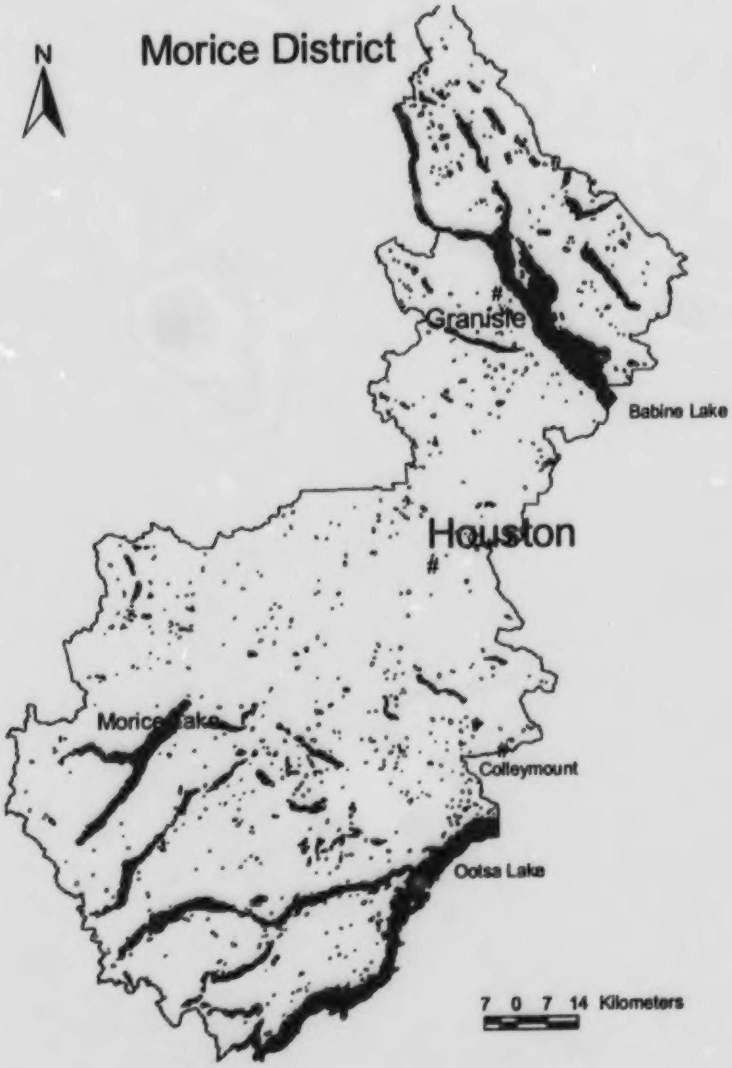
N
Morice District
Granisle
Babine Lake
Houston
Morice Lake
Colleymount
Ootsa Lake
7 0 7 14 Kilometers

Figure 1. Map of the Morice Timber Supply Area, Prince Rupert Forest Region.

1 Description of the Morice Timber Supply Area

The forests of the Morice TSA provide a wide range of forest land resources, including forest products (timber and non-timber), forage, minerals, recreation and tourism amenities, fishery and wildlife habitats. Good access to a diversity of landscapes, including lakes and rivers, provides a variety of recreation opportunities for both residents and tourists. Numerous Forest Service campsites and small provincial parks are located in the TSA. Summer activities include camping, hiking, fishing, boating, canoeing, wildlife viewing and back-country recreation. Hunting is popular in the spring and fall, for mule deer, mountain goat, moose, black bear and grizzly bear. Recreational activity in winter is high, including snowmobiling, ice fishing, and cross-country and back-country skiing. In addition, the beef ranching industry depends heavily for summer forage on Crown range land in the major valleys of the TSA.

1.1 The environment

The five biogeoclimatic zones* that occur in the Morice TSA reflect the diversity of climates and vegetation in the area. The varied ecological features and unique nature of the area contribute to the high biodiversity* values found in this TSA.

The Sub-Boreal Spruce (SBS) zone covers about 60% of the Morice TSA, occurring in valley bottoms to an elevation of about 1350 metres. This zone is characterized by seasonal extremes of temperature, with severe, snowy winters and relatively warm, moist and short summers. Frequent, large-scale fires occur in the SBS zone (the average fire return interval is 100 years). Lodgepole pine, hybrid spruce, subalpine fir and trembling aspen are the most common tree species.

The Engelmann Spruce-Subalpine Fir (ESSF) zone is the uppermost forested zone in most of the Morice TSA, occurring above the SBS zone and covering about 25% of the TSA. The ESSF zone has a continental climate, with cool, moist and short growing seasons, and long, cold winters. The ESSF zone is comprised of continuous forest at its lower elevations and parkland at its higher elevations. Subalpine fir is the dominant tree species throughout the zone; hybrid spruce and lodgepole pine are common in drier parts of the zone that have been influenced by fire.

The Coastal Western Hemlock (CWH) zone covers about 3% of the Morice TSA and is found at low to middle elevations in a narrow band around Morice, Nanika and Tahtsa lakes and around the western half of Whitesail Lake. The climate is predominantly coastal but is significantly influenced by continental weather patterns. As a result, the CWH zone is not as subject to winter cold spells and summer droughts as are the more interior zones. The dominant tree species are western hemlock, amabilis fir, mountain hemlock, lodgepole pine, trembling aspen and subalpine fir.

The Mountain Hemlock (MH) zone occurs above the CWH zone in the southwest portion of the TSA, and covers about 1% of the TSA. The MH zone's subalpine climate is characterized by short, cool summers and long, cool and wet winters. The deep winter snowpack is slow to disappear and a short growing season results. Mountain hemlock is the dominant tree species.

The Alpine Tundra (AT) zone occurs at high elevations mainly above the ESSF zone in the southwest of the TSA. The AT zone covers about 11% of the TSA. The climate is cold, windy and snowy with a short, cool growing season. Frost can occur at any time during the year. By definition this zone is treeless, although trees in stunted form are common at lower elevations. Vegetation is dominated by shrubs, herbs, mosses and lichens. Much of the alpine landscape lacks vegetation and is the domain of rock, ice and snow.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

The forests of the Morice TSA are home to many species of wildlife. Although best known for its moose population, the TSA also supports mule deer and, to a lesser degree, whitetail deer, grizzly and black bear, mountain goat, wolves, coyotes and a small herd of caribou. Significant populations of small mammals also exist, with pine marten, beaver and lynx being the most common. The rivers and lakes of the TSA support many fish species, including four species of salmon, steelhead, rainbow trout, kokanee, lake trout, Dolly Varden, bull trout, cutthroat trout, and whitefish. The Morice River provides some of the best angling opportunities in the province, especially for steelhead. Numerous lakes in the TSA also provide a range of fishing opportunities. Many of these fish and wildlife species are regionally or provincially significant while others are commercially important.

Under the *Forest Practices Code*, a process exists for identifying species at risk and designating wildlife habitat areas with specific management practices. Table 1 lists the identified wildlife species that occur in the five ecosections that overlap with the Morice TSA, according to Volume 1 of the provincial *Identified Wildlife Management Strategy*.

Table 1. Species at risk under the Forest Practices Code (February 1999)

Common names of identified wildlife	**Ecosection**				
	Kitimat Ranges	**Nechako Upland**	**Bulkley Basin**	**Babine Upland**	**Bulkley Ranges**
Bull trout	X	X	X	X	X
American bittern			X	X	
Trumpeter swan		X	X	X	X
Northern goshawk *atricapillus*	X	X	X	X	X
Fisher	X	X	X	X	X
Grizzly bear	X	X	X	X	X
Mountain goat	X	X			X

Source: Managing Identified Wildlife, Volume 1, February 1999.

Current forest management practices follow the legislation and guidelines set out by the *Forest Practices Code*. Consequently, the protection of wildlife and the environment will be managed through the *Code*. In addition, locally-developed plans such as LRUPs and the *Telkwa Caribou Interim Management Guidelines*, provide further management direction for public forest lands in the Morice TSA, as well as for wildlife species not included in the above list.

1.2 First Nations

There are six First Nations with traditional territory within the Morice TSA, as well as 17 Indian reserves. The First Nations are the Lake Babine Nation, Cheslatta Carrier Nation, Broman Lake Band, Nee-Tahi-Buhn Band, Skin Tyee Band Nation, and Wet'suwet'en Hereditary Chiefs. Only the Lake Babine Nation has year-round communities within the TSA, located at Fort Babine and at the Tachet reserve in Topley Landing. All of the above First Nations have filed Statements of Intent with the British Columbia Treaty Commission, claiming traditional territories that cover almost all of the Morice TSA. Once the treaties or related agreements have been finalized, they will be considered in a future Timber Supply Review.

A number of First Nations people are employed with local forest companies, and some bands have direct involvement in the forest industry, through silviculture contracts, small forest licences or joint ventures with non-aboriginal companies. Trapping, hunting and fishing are traditional activities that are important to the economic and social structure of First Nations communities in the area. All of the First Nations have expressed concerns about timber harvesting in areas with high cultural and economic values. The protection of traplines is particularly important.

The Morice TSA contains numerous known sites and areas of cultural significance for First Nations, including large numbers of culturally modified trees (CMT)*. An archaeological overview assessment (AOA), which identifies sites of potential cultural and heritage significance, has been developed for the TSA. As archaeological impact assessments (AIAs) and traditional-use surveys are completed, they are considered in operational planning. Any available information regarding cultural or archaeological sites is considered in the timber supply review process however no information was available to allow specific land base exclusions on management practices in this analysis.

Culturally modified tree
A tree or a remnant of a tree with evidence of traditional aboriginal forest use.

2 Information Preparation for the Timber Supply Analysis

Timber supply analysis requires three general categories of information: land base inventory; timber growth and yield; and management practices. These three categories are discussed below. Also, in preparation for the analysis, a number of changes since the 1996 Morice TSA timber supply analysis were noted, and are described in Section 2.4, "Changes since the 1996 Morice TSA analysis."

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 2000 by the B.C. Forest Service. This file contains information on the forest land in the Morice TSA including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other characteristics such as environmental sensitivity and physical accessibility (operability). Stand attributes such as tree height, stocking* and age have been projected to 2000. The inventory file has been updated to account for timber harvesting using Forest Development Plan (FDP) information and is current to either 1998 (Houston Forest Products FDP) or 1999 (other FDPs) for the Morice TSA.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development. A description of these areas specific to the Morice TSA is provided below. These types of areas do not contribute to the timber harvesting land base* of the Morice TSA. Before assessing timber supply, these non-contributing areas are identified and separated from the timber harvesting land base.

Identifying areas as not contributing to timber supply does not mean the area is removed from the Morice TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

This section describes the types of areas that do not contribute to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value, and sites of adequate environmental resilience, to accommodate timber harvesting with due care for other resources.

For the Morice TSA, the following types of areas were excluded from the timber harvesting land base.

- not managed by the B.C. Forest Service — these are non-Crown areas, such as private land and Indian Reserves, areas managed by other agencies such as parks and agricultural licences and land in woodlot licences not administered as part of the TSA.
- agricultural leases — areas leased for agricultural activities.
- non-forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).

Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Timber harvesting land base
Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.

- recreation areas — areas which are deemed to be of high recreational value.
- environmentally sensitive areas (ESA)*— areas with sensitive soils or where there may be difficulty regenerating a new crop of trees.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons and all areas above 1360 metres in elevation (Morice Forest District staff determined that little harvesting is occurring above 1360 metres in elevation and therefore, these high-elevation sites were removed from the timber harvesting land base).
- non-commercial cover areas — areas occupied by non-commercial tree and brush species.
- non-merchantable forest types* — areas occupied by forest types* currently considered not economic for harvesting because they contain too high a proportion of poor quality, low value timber species.
- sites with low timber productivity — areas occupied by forest with low timber growing potential (have volumes at maturity not currently being harvested as demonstrated by Forest Development Plans).
- riparian area* — area unavailable for harvesting due to the need to provide protection for riparian and stream ecosystems.
- existing unclassified roads, trails and landings (RTLs) — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- unavailable areas — additional areas that will not be accessed in the future due to the high development cost relative to the value of timber being accessed.

A more detailed description of these categories, including specific criteria for exclusion is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category, and shows the area of the timber harvesting land base. The column "Crown forest area by classification" provides the total forested area managed by the B.C. Forest Service within the given category. For example, while there is a total of 101 338 hectares of forested land classified as low productivity sites, only 51 846 hectares were excluded at that point of the land base determination. The difference arises because the actual area excluded depends on the sequence of the reduction (e.g., areas previously excluded as inoperable may have overlapped with low productivity stands, thus reducing the area explicitly excluded due to low productivity).

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Non-merchantable forest types
Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Forest type
The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Table 2. Determination of the timber harvesting land base for the Morice TSA

Classification	Crown forest area by classification	Area (hectares)	Per cent of total TSA area	Per cent of Crown forest area
Total TSA area		1 500 349	100	
Not managed by the B.C. Forest Service		59 527	4.0	
Agricultural leases		21 130	1.4	
Non-forest land		457 784	30.5	
Total forested area managed by the B.C. Forest Service (Crown forest)[a]		961 908	**64.1**	**100**
Reductions to Crown forest:				
Recreation areas	6 503	6 503	0.4	0.7
Environmentally sensitive areas	109 897	107 425	7.2	11.2
Inoperable	32 090	21 492	1.4	2.2
Non-commercial cover	6 342	5 111	0.3	0.5
Non-merchantable forest types	51 355	40 137	2.7	4.2
Low productivity sites	101 338	51 846	3.5	5.4
Riparian areas	13 475	9 282	0.6	1.0
Existing roads, trails, and landings	10 852	10 067	0.7	1.0
Unavailable areas	64 939	26 081	1.7	2.7
Total current reductions		277 946	18.5	28.9
Current timber harvesting land base (includes 22 525 hectares not satisfactorily restocked (NSR)[a,b]		**683 962**	**45.6**	**71.1**
Future reductions				
Future roads		19 171	1.3	2.0
Future timber harvesting land base		**664 791**	**44.3**	**69.1**

(a) The total area in woodlots is 18 935 hectares and is excluded from the timber harvesting land base.

(b) Not satisfactorily restocked areas include current and backlog areas.

Notes:

1) Areas proposed for protection under the protected area strategy remain part of the timber harvesting land base, but are deferred from harvest for the next 10 years.

2) Total area contributing to biodiversity is 964 947 hectares.

Not satisfactorily restocked (NSR) areas

An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents the total Morice TSA and the Crown forested land base. The chart shows that about 5.4% of the total land base is classified as not managed by the B.C. Forest Service, and 30.5% is classified as non-forest or non-productive forest (i.e., having very few trees). The Crown forested area chart details the categories of forest land and shows that about 28.9% of the forest land in the Morice TSA is considered to be unavailable for harvesting. The main reasons for unavailability are environmental sensitivity and low site productivity. Approximately 71.1% of the Crown forested area is considered available for timber harvesting (including not satisfactorily restocked (NSR) stands).

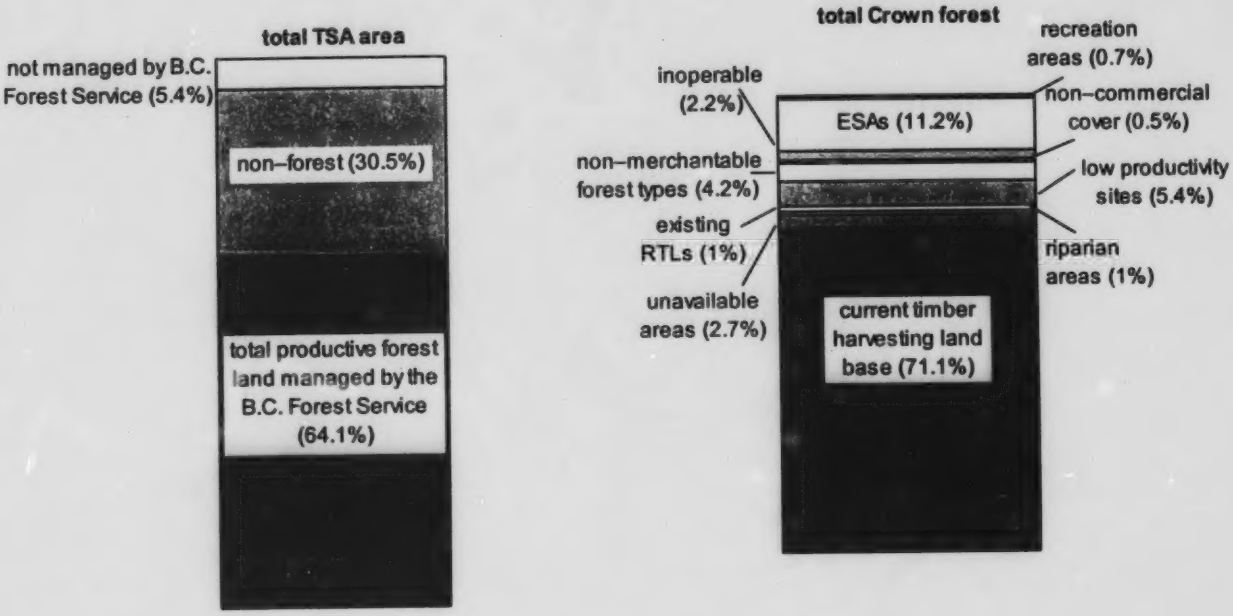

Figure 2. Composition of the total and Crown forested land bases — Morice TSA, 2002.

Figure 3 and Table 3 show the distribution of biogeoclimatic (BEC) variants* in the total forested area and in the timber harvesting land base. Table 3 shows the proportion of each BEC variant that is unavailable for harvest. For example, the ESSFmc variant makes up 17.0% of the total forested area and 13.4% of the timber harvesting land base, while 44.2% of the total area of ESSFmc is outside of the timber harvesting land base. The numbers in the last column of Table 3 suggest that the forest outside the timber harvesting land base will meet most of the old-seral* requirements if it is well-distributed among the landscape units (LU)*.

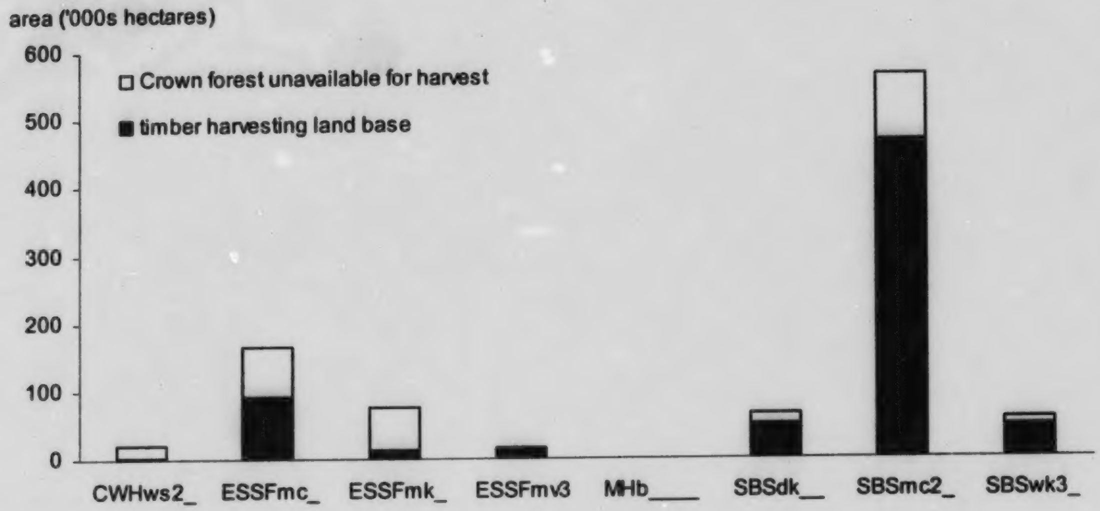

Figure 3. Area by biogeoclimatic classification — Morice TSA, 2002.

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Old seral
Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Table 3. Summary of biogeoclimatic zone areas — Morice TSA, 2002

Biogeoclimatic ecosystem classification (BEC) zone/variant	Per cent of total forested area in BEC variant	Per cent of timber harvesting land base in BEC variant	Per cent of BEC variant outside the timber harvesting land base
CWHws2_	2.2	0.2	92.5
ESSFmc_	17.0	13.4	44.2
ESSFmk_	7.9	2.0	82.3
ESSFmv3	1.7	1.7	25.6
MHb____	0.1	0.0	98.4
SBSdk__	6.8	7.3	23.8
SBSmc2_	58.4	68.3	16.9
SBSwk3_	5.9	7.1	14.9
Total	100	100	Not applicable

Figure 4 shows the current composition of the timber harvesting land base by dominant tree species. Pine dominates 51% of stands in the timber harvesting land base, spruce dominates 25% of stands and balsam 24%. After harvest, pine and spruce stands are generally regenerated to mixtures of pine and spruce. Balsam sites are planted to mixtures of spruce and pine with some natural ingress of balsam expected.

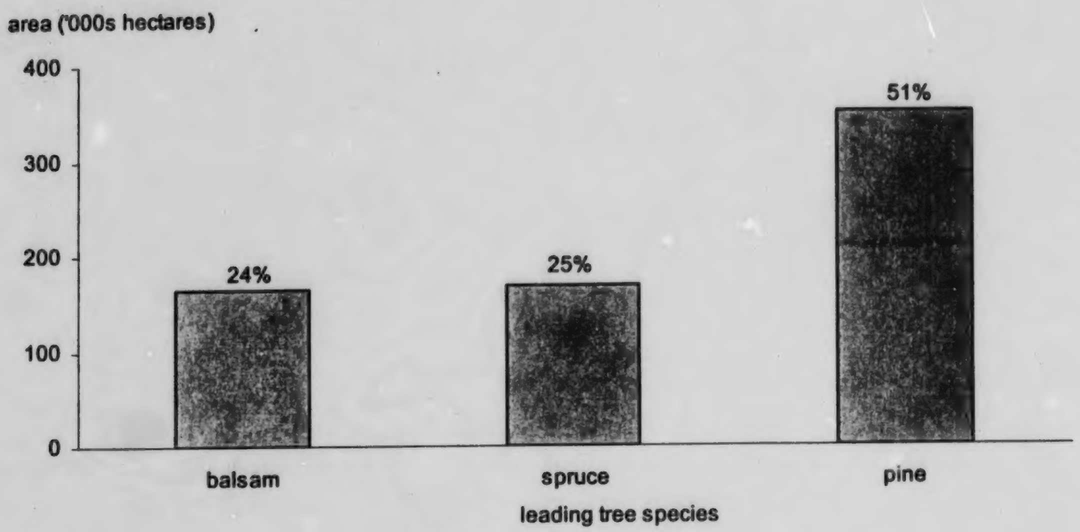

Figure 4. Area by dominant species — Morice TSA timber harvesting land base, 2002.

Figure 5 shows the proportion of area for each species that consists of young managed (younger than 35 years), unmanaged thrifty and old stands (over 140 years of age). In total, about 21% of stands in the timber harvesting land base have a history of logging and subsequent management treatments; the other 79% of stands generally have not been harvested and therefore have no management history. Although it appears as if there was little logging activity in balsam stands, logging has actually been proportional to the amount of balsam in the TSA (Forest Development Plan past harvesting information). Few managed balsam stands exist because, after harvesting, balsam stands are converted to a mixture of spruce and pine (see Appendix A, "Description of Data Inputs and Assumptions for Timber Supply Analysis" for details on regeneration strategies).

For the total timber harvesting land base, about 42% of the area is occupied by stands over 140 years of age. The majority of stands older than 140 years of age are balsam stands. Spruce stands tend to be younger than balsam stands and pine stands are younger still, likely due to the frequency of fire where these species are common.

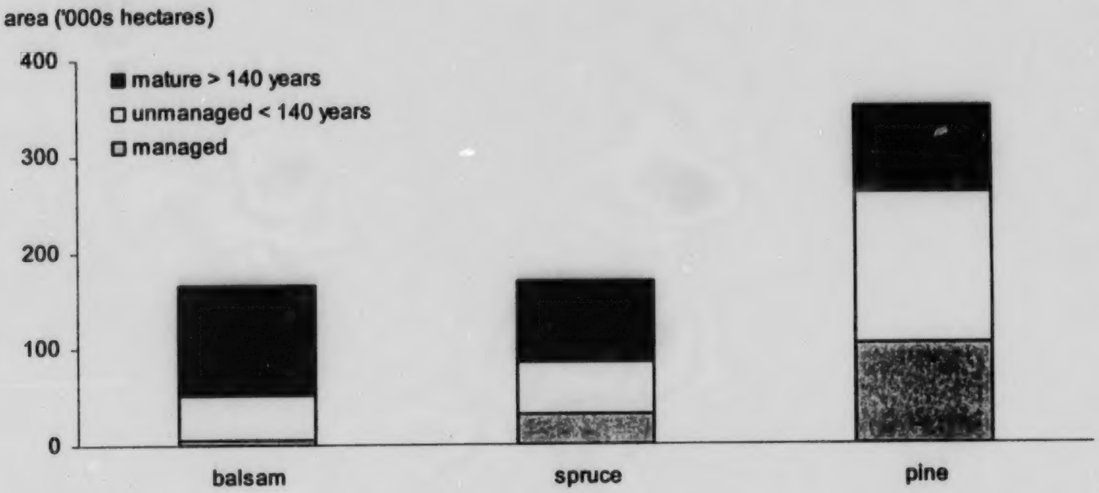

Figure 5. Area by age classification — Morice TSA timber harvesting land base, 2002.

Figure 6 shows the distribution of site productivity of the dominant stand types within the timber harvesting land base. Thirty-three per cent of the stands are classified as having relatively good site productivity. Stands with medium site productivity occupy 45% of the area, and those with relatively poor site productivity, 22%. Pine dominated stands have the highest proportion of good productivity sites and balsam stands the highest proportion of poor productivity sites.

Stands of very low productivity (currently not harvested at maturity) were excluded from the timber harvesting land base. Forest Development Plan information was used to define which areas were of such low productivity that harvesting rarely occurred in them, and should be removed from the timber harvesting land base.

The underestimation of site productivity of pine dominated stands in the Morice TSA has been documented and productivity adjustment equations developed. In this analysis, the site productivity of pine dominated stands was adjusted after the existing stands were harvested.

Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains further information on which stands were excluded from the timber harvesting land base due to low site productivity and what site index (SI)* adjustments were applied to pine dominated stands.

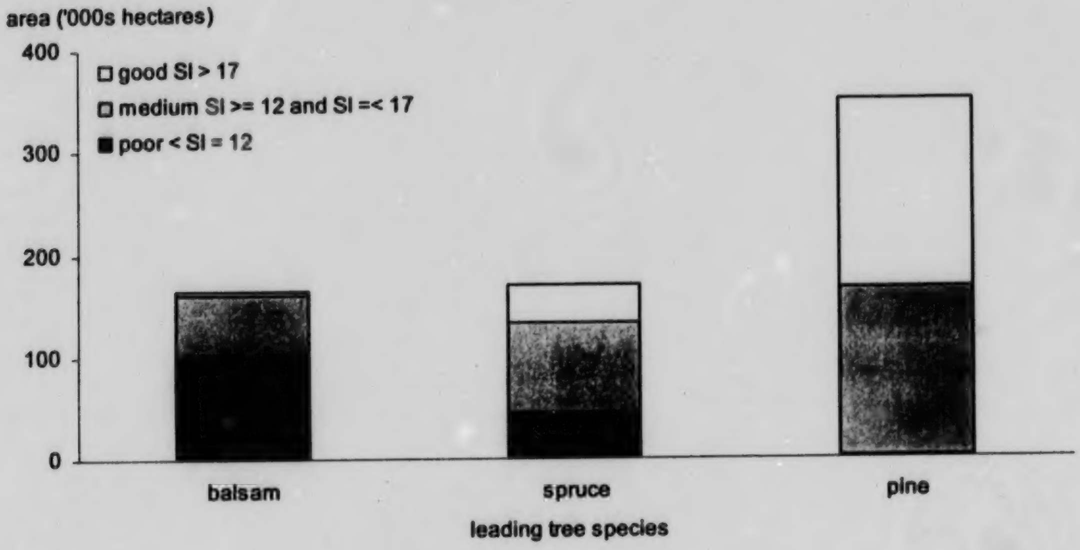

Figure 6. Area by dominant species and site productivity — Morice TSA timber harvesting land base, 2002.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Figure 7 shows the current age class composition of forested stands in the Morice TSA. About 4% of the timber harvesting land base is occupied by stands older than 250 years. About 18% of the area is covered with stands 20 years or younger, 20% with stands between 21 and 100 years old, and 58% with stands between 101 and 250 years of age.

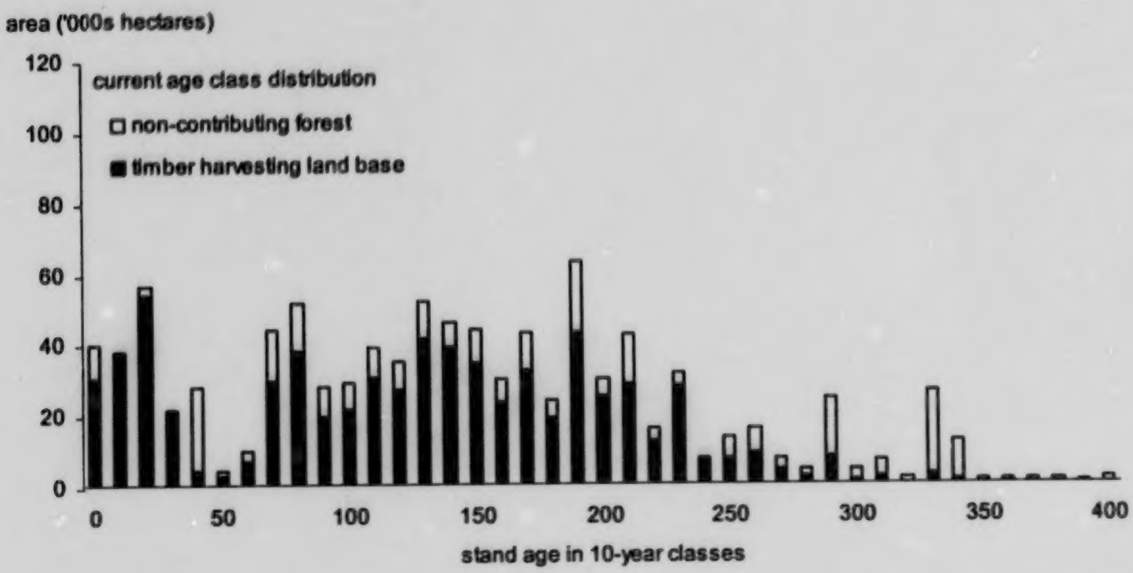

Figure 7. Current age class composition — Morice TSA forested land base, 2002.

The age class distribution of forested stands excluded from the timber harvesting land base also affects timber supply. Although they do not contribute directly to timber supply, these areas can affect how much harvesting can be conducted and the pattern of the harvesting within the TSA through their ability to provide old-forest and biodiversity attributes. The total forested land base in the Morice TSA, which includes some land not managed by the B.C. Forest Service, is approximately 965 000 hectares. A portion of the total forest area — 29% — does not contribute to the timber harvesting land base. About 28% of these "non-timber harvesting land base" stands are older than 250 years. Only 4% of the stands are 20 years or younger, 26% are between 21 and 100 years old, and 42% are between 101 and 250 years of age.

The non-timber harvesting land base provides much of the area needed to meet old-forest biodiversity requirements. In the analysis however, stands in the non-timber harvesting land base currently below 240 years of age are prevented from growing older (fire or pest activity is assumed to keep them younger than 240 years of age) and do not contribute to forest-level biodiversity requirements (needing stands of at least 250 years of age) as a result. Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains further information on "aging" of the non-timber harvesting land base.

2.2 Timber growth and yield

Two growth and yield models were used to estimate timber volumes for the Morice TSA analysis. The variable density yield prediction (VDYP)* model developed by the Ministry of Sustainable Resource Management, Terrestrial Information Branch, was used for estimating volumes in unmanaged coniferous* stands. The table interpolation program for stand yields (TIPSY)*, developed by the B.C. Forest Service, Research Branch, was used to estimate yields for coniferous managed stands. Managed stands were those harvested during the past thirty-four years, as they are considered managed to current standards. Stands harvested more than thirty-four years ago are considered unmanaged.

Timber volume estimates* assume a specific utilization level, or set of dimensions, which establish the minimum sizes of trees and logs that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree as well as a maximum stump height.

Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains details on the definition of managed stands, utilization standards and the specific model versions used.

Volume estimation and prediction are subject to uncertainty due to uncertainties in inventories which form the basis for estimating site productivity, limited experience with second-growth in British Columbia, and the long time frame over which trees grow. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates, the current timber inventory on the timber harvesting land base is approximately 137 million cubic metres. About 126 million cubic metres, or 92% of the total, are in stands currently merchantable; that is, older than minimum harvestable age (MHA).

Variable Density Yield Prediction model
An empirical yield prediction system supported by the Ministry of Sustainable Resource Management, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.
Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Table Interpolation Program for Stand Yields
A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

2.3 Management practices

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The *Forest Practices Code of British Columbia Act* and associated regulations guide forest management practices in the Morice TSA. The focus of the timber supply review is to assess timber supply based on current management practices as implemented for the area. Current management is described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Staff in the Morice Forest District provided descriptions for the following management practices:

- Silviculture — reforestation activities required to establish free-growing* stands of preferred and acceptable tree species. Areas in the Morice TSA are harvested using a clearcut harvesting* system and restocked by planting or natural regeneration.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Clearcut harvesting
A harvesting method in which most trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.

- Forest health and unsalvaged losses* — timber losses to fire and pest (insect) damage are expected to average 171 959 cubic metres per year over the first 50 years and 104 572 cubic metres per year over the remainder of the 250 year analysis horizon.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Cutblock adjacency* and green-up* — in the Morice TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (three metres in height for the integrated resource management (IRM) area), before adjacent stands may be harvested. The purpose of the cutblock adjacency guideline is to prevent timber harvesting from becoming overly concentrated in an area. This guideline was modelled by limiting the area within the IRM zone that does not meet green-up conditions to a maximum of 25%.
- Maintenance of scenic values — maintaining important scenic values requires that visible evidence of harvesting must be kept within limits in some areas of the Morice TSA. The maximum proportion of each scenic area that may be covered by young stands that do not meet visual green-up requirements (five metres in height) varies depending on the forest characteristics, the visual quality objectives (VQO)* and the visual absorption capability (VAC) for each area, ranging between 1% and 25%.
- Maintenance of Telkwa Caribou recovery area — a minimum of 25% of the timber harvesting area is to be maintained in stands that are more than 90 years old.
- Protection of environmentally sensitive areas — areas where sensitive soils, recreation values and forest regeneration problems have been identified. To maintain ecological or other resource values, land has been partially or entirely excluded from the timber harvesting land base.
- Maintenance of Morice LRUP Zone A values — areas of high value for fish, wildlife and recreation values. While some harvesting may be permitted in these areas to address health issues, the maximum area below green-up is limited to 1%.

Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

- Minimum harvestable ages (MHAs) — the time it takes for stands to grow to a merchantable condition. Spruce and pine stands were considered merchantable when they attained a volume of 150 cubic metres per hectare and balsam stands were considered merchantable when they attained a volume of 200 cubic metres per hectare. Actual harvest age is generally greater but never less than the minimum, and will depend on ages of other available stands, forest cover objectives* and overall timber harvest targets.
- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit, the *Forest Practices Code* specifies targets for the proportion of the area in each biogeoclimatic variant that should be covered by stands with old-forest characteristics. Within the Morice TSA, old forest is characterized by stands greater than 250 years of age except in the sub-boreal spruce biogeoclimatic zone where old-forest characteristics are exhibited in stands at 140 years of age. Since landscape units and biodiversity emphasis options (BEOs) are still in draft form in the Morice TSA, a weighted average old-seral requirement was applied in the analysis (see Section A.4.10, "Forest cover requirements" in Appendix A).
- Stand-level biodiversity* — to maintain biological diversity in forest stands, wildlife tree* patches (WTP) are retained after harvesting. In the Morice TSA, retention of wildlife tree patches has been modelled by reducing all yield curve volumes by 3.6%.

The data package for the Morice Timber Supply Area (TSA) was released in March 2001. As a result of public input, changes were made to the data package. The revised data package, which includes detailed descriptions of the management practices and the assumptions used to incorporate them into the analysis, is presented in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" of this document.

Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency and Green-up).

Landscape-level biodiversity
The Landscape Unit Planning Guide provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Figure 8 shows the proportions of the timber harvesting land base according to the forest management objectives for those areas. The total area shown in the bar chart exceeds the size of the timber harvesting land base by about 1%. This is because more than one management objective can been applied to the same area.

In the Morice TSA the Telkwa Caribou Recovery Area overlaps with the Morice LRUP Zone A area.

An area managed for an objective such as visual quality includes non-timber harvesting land base as well as timber harvesting land base. The percentages shown in Figure 8 are only for the timber harvesting land base portion of the area managed for that objective.

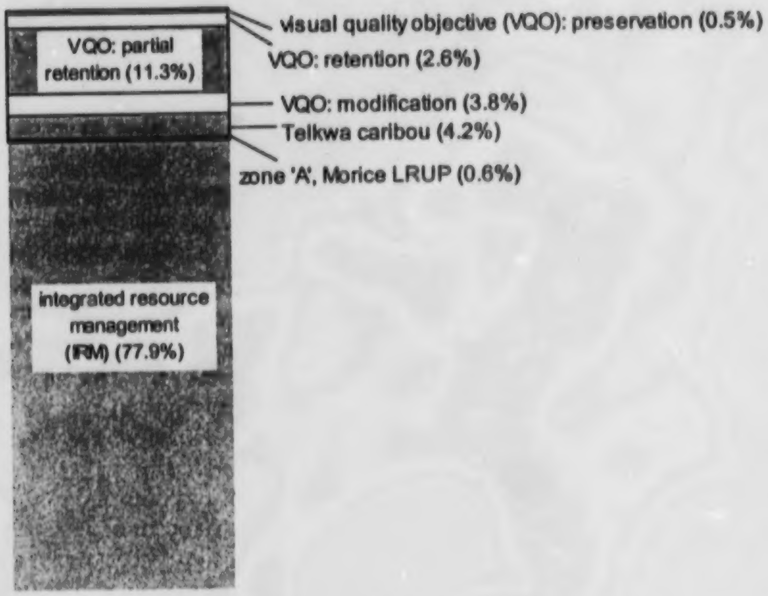

Figure 8. Timber harvesting land base by management emphasis — Morice TSA, 2002.

2.4 Changes since the 1996 Morice TSA analysis

The objective of this section is to present the major changes to the land base and forest management assumptions since the last analysis.

- The timber harvesting land base is approximately 50 000 hectares larger in this analysis. This is largely due to a reduction in the size of the area excluded for low productivity. Forest Development Plan information was used to refine areas classified as having productivity too low to remain in the harvesting land base.
- Some additional areas were excluded from the timber harvesting land base due to the high development cost relative to the value of timber being accessed (see Appendix A, Section A.3.12).
- Implementation of the *FPC* has increased land base reductions for riparian reserves and management zones. Stand-level biodiversity is accommodated through the retention of wildlife tree patches. In this analysis the effect of wildlife tree patch retention was modelled by reducing the volume curves rather than excluding forested land. Additional constraints, which also often limit the availability of the timber harvesting land base, are the requirements to maintain (or recruit) suitable areas of old forest for landscape-level biodiversity.
- Stands in this analysis were grouped, to better approximate operational harvest choices. Stands proposed for harvest within Forest Development Plans were given the highest harvest priority. Pine stands older then 120 years and spruce stands older than 140 years were given the second highest priority. When the age of stands available for harvest fell below 120 years or 140 years, remaining stands above culmination of mean annual increment* (CMAI) age were given the third highest priority as a group. Finally if harvest still could not be met, remaining stands above minimum harvestable age were prioritized for harvest as a group. Harvest of stands within groups in all cases was random.

In summary, the timber harvesting land base increased in size by 7.8% and some modelling assumptions have changed since the last analysis. Given the extent of these changes, direct comparisons between this and the previous analysis cannot be made. Each analysis needs to be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. As noted in the introductory section, there is uncertainty surrounding information used in the analyses, and forest management objectives change over time, which is one of the major reasons why the *Forest Act* requires the chief forester to review the timber supply and AAC for each TSA periodically.

Any changes to the land base or management assumptions that occur or become effective after the completion of this timber supply analysis, but before the AAC determination, will be presented to the chief forester for consideration during the AAC determination, if possible.

Mean annual increment (MAI)
Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age (CMAI). Harvesting all stands at this age results in a maximum average harvest over the long term.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Morice TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service (Forest Service Simulator (FSSIM) version 4.1a) was used to aid in the assessment. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast* (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes and the management regime to represent how trees grow and are harvested over a long period of time. Generally, only the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of green-up and old-forest prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model facilitates examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implication of a particular management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports sustainable forest management in the field.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

4 Results

This section presents results of the timber supply analysis for the Morice TSA. The base case harvest forecast* uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." The impacts of uncertainty in the inputs to the analysis will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case provides only a part of the timber supply picture for the Morice TSA, and should not be viewed in isolation of the sensitivity analysis*.

Section 2.4, "Changes since the 1996 Morice TSA analysis," provides an overview of the major changes to the land base and management assumptions since the last analysis. As noted in that section, any comparison between this and the last analysis should be made with recognition of the extent and nature of those changes. Each analysis should be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. Finally, one of the major reasons the chief forester is required under the *Forest Act* to periodically review the timber supply and AAC is to account for changes in management, information and knowledge.

4.1 Base case harvest forecast

The base case harvest forecast for the Morice TSA represents current management as described in the various sections of Appendix A of this report. Figure 9 shows the base case harvest forecast for the Morice TSA. The initial harvest level of 1 961 117 cubic metres per year (referenced as 1.96 million cubic metres from here on), is the current AAC of 1 985 815 cubic metres per year, less 24 698 cubic metres per year that has been issued to new woodlot licences. An annual harvest level of 1.96 million cubic metres can be maintained for four decades before declining by 8.2% to the long-term harvest level* of 1 803 000 cubic metres per year.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

Sensitivity analysis
A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

4 Results

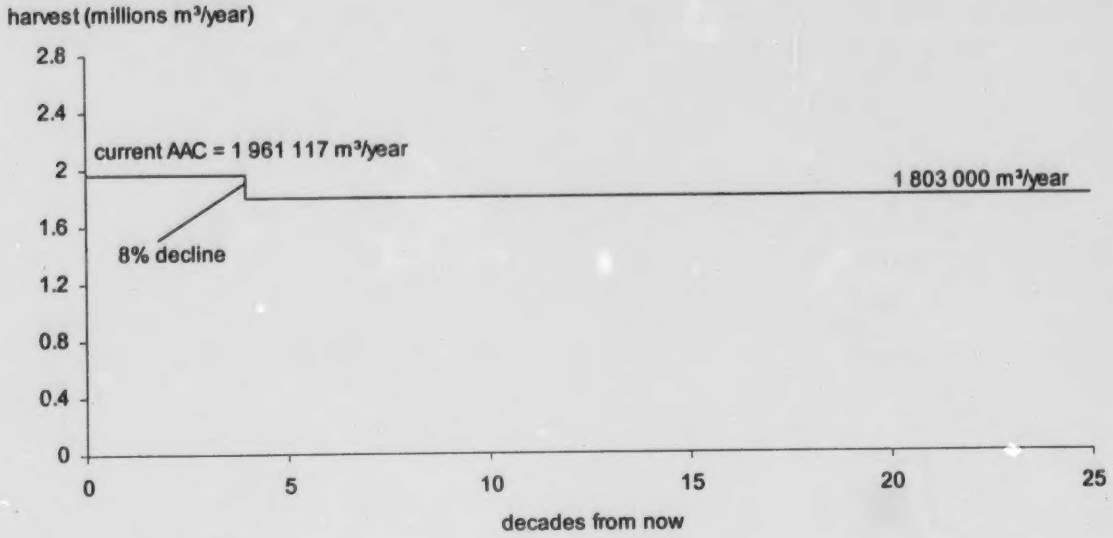

Figure 9. Base case harvest forecast — Morice TSA, 2002.

Unsalvaged losses due to natural forces such as insects and fire are estimated to be 171 959 cubic metres per year for the first 50 years and 104 572 cubic metres per year for the remaining 200 years of the planning horizon. The unsalvaged losses have been subtracted from all harvest forecasts shown in this report.

In the short- and medium-terms the harvest forecast for this TSA depends on the amount of currently existing timber growing stock*. Figure 10 shows a projection of timber inventory volumes over time corresponding to the base case harvest forecast. Total growing stock on the timber harvesting land base declines over the next 9 decades from 136.9 million cubic metres as the older existing mature stands are harvested and replaced by younger second-growth. Over the long term, the average total growing stock for the base case is about 87 million cubic metres.

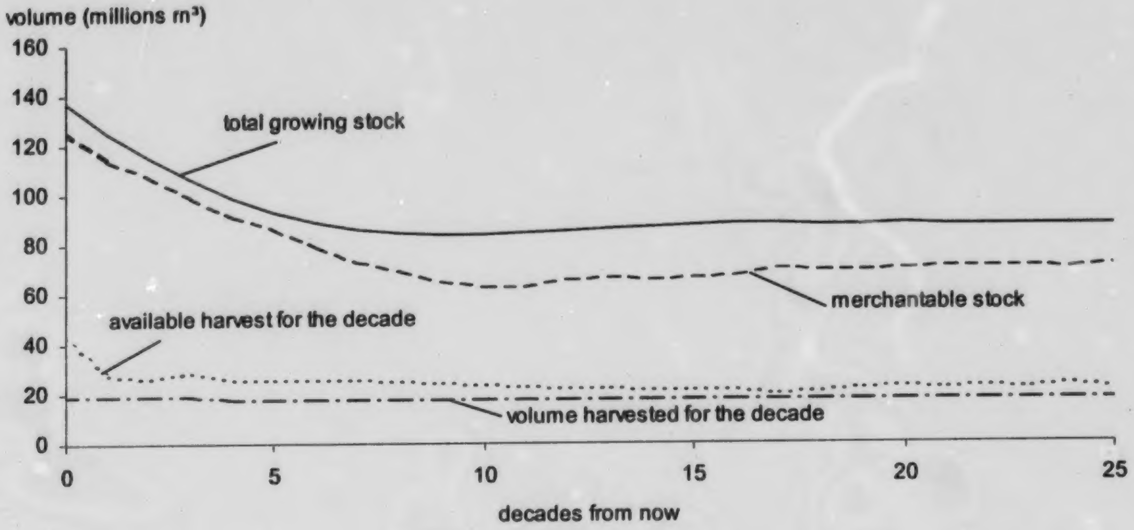

Figure 10. Total, merchantable and available growing stocks — Morice TSA, 2002.

About 125.8 million cubic metres, or 92% of the total growing stock, are in stands considered currently merchantable, that is, older than minimum harvestable age. The total merchantable growing stock over the long term averages about 68 million cubic metres. Even though timber may be merchantable it may not be available for harvesting because the stands are required to satisfy other resource requirements, such as maintenance of scenic values, biological diversity or green-up, as defined in Appendix A. The volume of timber initially available for harvest, while satisfying all the forest cover constraints imposed in this analysis, is about 43.9 million cubic metres. Available timber volume decreases to about 20 million cubic metres by decade 17 and then recovers to about 22 million cubic metres by the end of the forecast. Also shown on this graph is the volume of timber harvested in the base case. Although it appears the harvest forecast could be pushed slightly higher, additional volume would come from stands harvested below the age where productivity is maximized resulting in a lower harvest level thereafter. In addition, the small difference between the volume harvested and the volume available indicates there will likely be limited flexibility for managers planning harvesting operations in the near future and, if additional forest cover constraints are applied, harvest levels could be impacted.

Growing stock
The volume estimate for all standing timber at a particular time.

4 Results

The base case long-term harvest level of 1 803 000 cubic metres per year is the harvest rate that can be achieved while maintaining the total timber growing stock on the timber harvesting land base at an even level, on average, over the long term. A constant level of growing stock indicates that harvesting can continue at the corresponding harvest level in perpetuity. A continually increasing level of growing stock would indicate that the timber is being harvested below the productive capability of the land. A continually declining level of growing stock would signify that the timber is being harvested above the productive capability of the land.

Figure 11 shows the transition of harvesting from existing to managed stands, and the amount that each makes up in the base case forecast. For the first five decades the harvest depends fully on existing stands; during decades 6 through 16 the harvest becomes increasingly dependent on managed stands. The high volume of existing older stands and available growing stock allows harvesting to occur in this TSA at the long-term level before managed stands dominate the harvest.

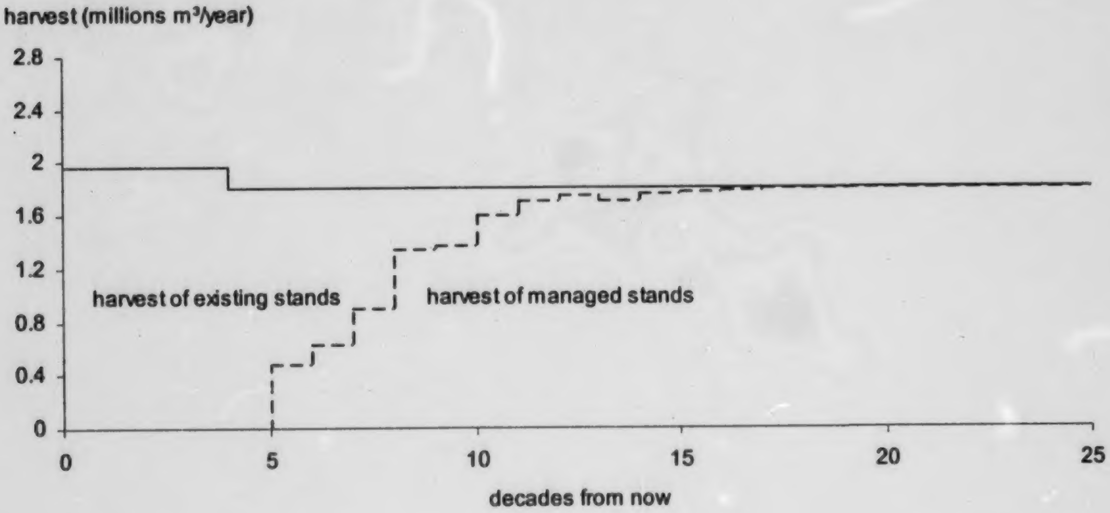

Figure 11. Harvest contribution from existing and managed stands — Morice TSA, 2002.

4.2 Average age, area, and volume harvested

Figure 12 tracks the change in the area-weighted average harvest age resulting from the base case forecast. Initially the harvest comes from older stands in the timber harvesting land base. During the first 40 years of the forecast, the average harvest age is about 181 years. The average harvest age then gradually declines through decade 12 to about 86 years of age, as harvest moves from existing unmanaged to managed stands. The average age of the stands harvested over the long-term is about 94 years. Areas of the TSA managed for maintenance of scenic values or other resource values (e.g., Morice LRUP Zone A) have more harvesting constraints resulting in a slower rate of harvest and higher average harvest age. Areas managed primarily for timber production are harvested at a faster pace, resulting in lower average harvest ages.

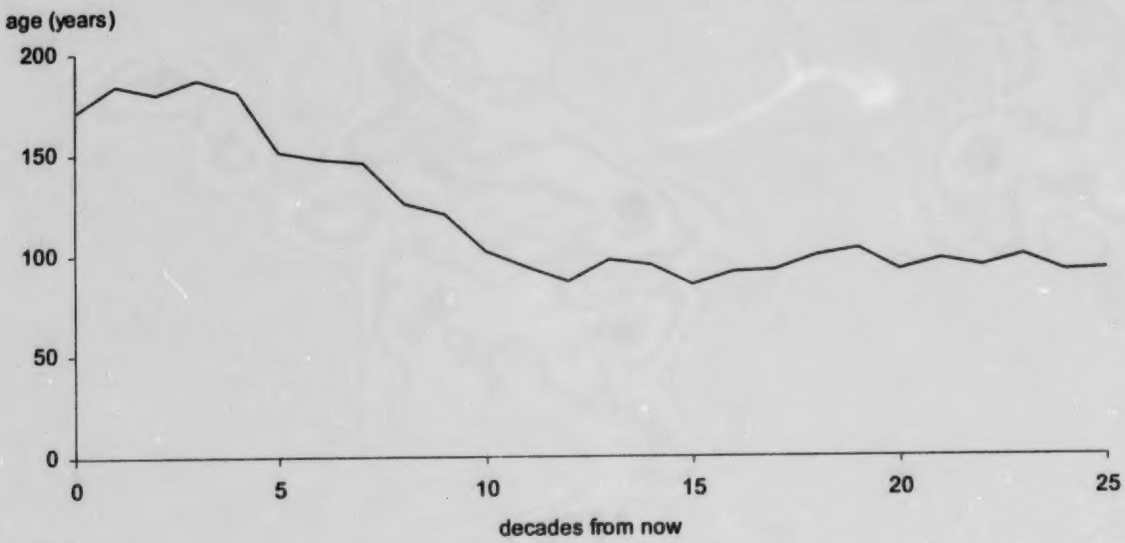

Figure 12. Average age of stands harvested over time — Morice TSA base case, 2002.

4 Results

Figure 13 shows the average volume per hectare harvested over time under the base case harvest forecast. For the first 10 decades, while the timber supply is forecast to come primarily from unmanaged stands, the average volume harvested is about 304 cubic metres per hectare (varying from 287 to 320 cubic metres per hectare). After decade 10, when the timber supply is forecast to come primarily from younger managed stands, the average volume harvested is about 284 cubic metres per hectare (varying from 271 to 309 cubic metres per hectare). The average volume harvested over the full planning horizon is 291 cubic metres per hectare.

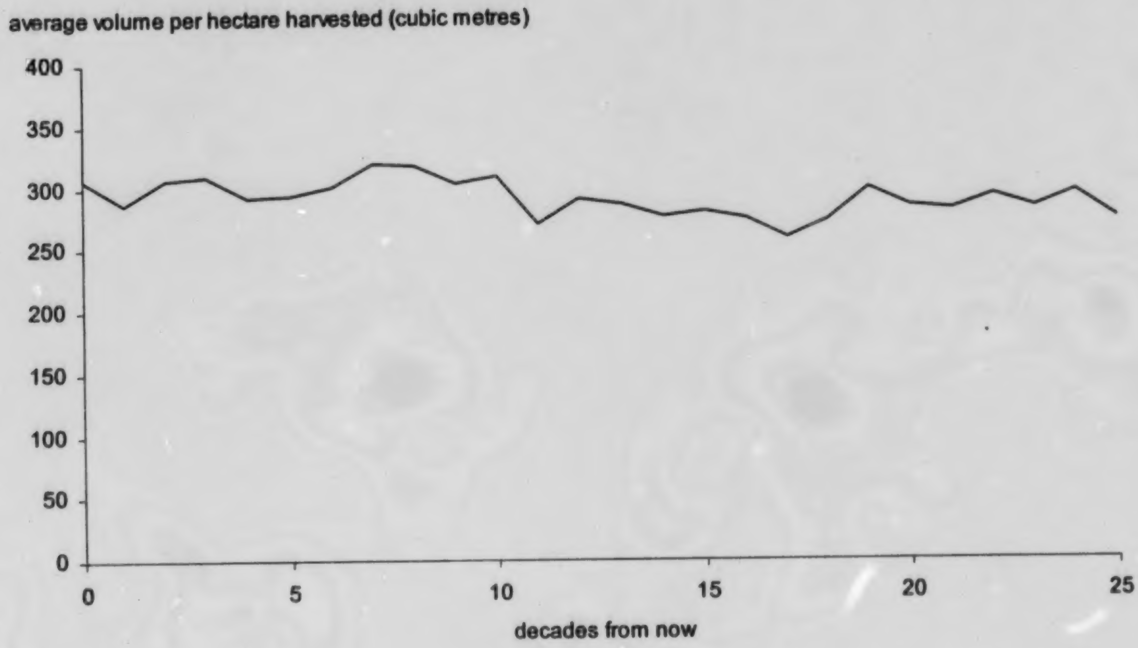

Figure 13. Average volume per hectare harvested over time — Morice TSA base case, 2002.

Figure 14 shows the average annual area harvested over time for the entire Morice TSA, the integrated resource management areas, and the areas subject to forest cover constraints for the maintenance of scenic values (the visual quality preservation group is not shown due to the very small area harvested). For the entire Morice TSA, the annual area harvested during the first seven decades decreases from approximately 7000 hectares to about 6000 hectares. Area harvested in the first seven decades is impacted by reduced harvest levels after four decades and reduced volumes deducted for non-recoverable losses (NRLs) after five decades of the timber supply forecast. The small increase in the area harvested after decade 10 coincides with the slightly lower volumes being harvested in younger managed stands. Over the full planning horizon the average annual area harvested is approximately 6700 hectares per year. The majority of the area harvested is in the integrated resource management group followed by the areas managed for scenic (visual) values. It should be noted that harvesting in visually sensitive areas occurs over the entire forecast at a fairly consistent level, with the exception of the initiation of the harvest forecast. This is due to the limited amount of area proposed for harvest in visual areas within forest development plans (in the analysis, stands currently identified in Forest Development Plans are harvested first).

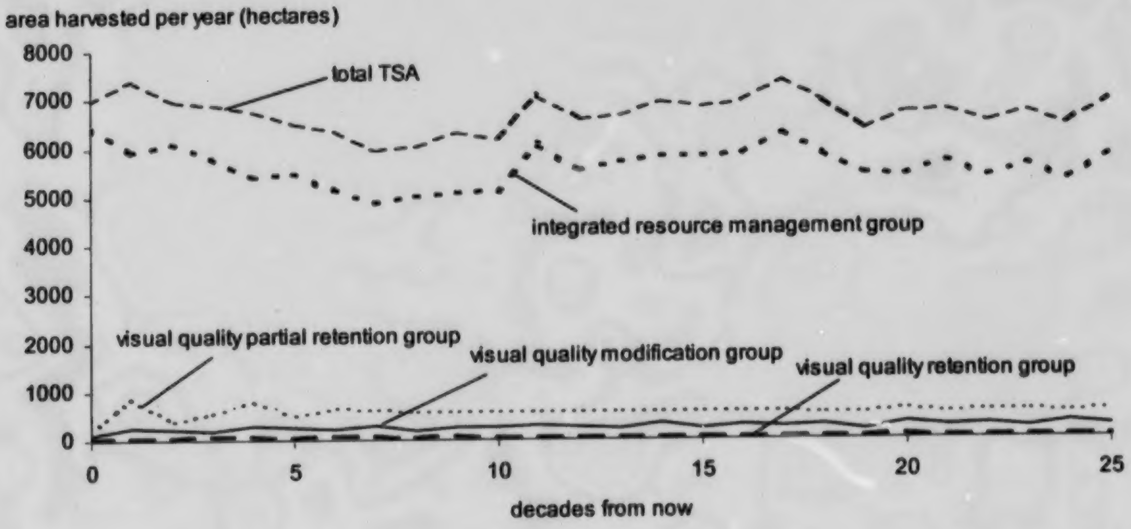

Figure 14. Average area harvested per year over time for the Morice TSA, integrated resource management areas and areas subject to forest cover constraints for scenic values — Morice TSA base case, 2002.

4.3 Age class profile over time

The charts in Figure 15 show how the age composition of the Morice TSA productive forest land base changes over the next 150 years under the base case harvest forecast.

There are approximately 965 000 hectares of productive forest land base within the Morice TSA analysis area, of which 683 962 hectares (71%) make up the initial timber harvesting land base (contributing forest). The current age class distribution is well distributed across all age classes and shows about 66% of stands within the timber harvesting land base are at or above minimum harvestable age. Forty-two per cent of stands on the timber harvesting land base are above 140 years of age and 4% are above 250 years of age.

The productive forest land base also contains stands that have been excluded from the timber harvesting land base (non-contributing forest). Outside of the timber harvesting land base, 57% of the stands are above 140 years of age and 27% of the stands are older than 250 years of age.

As mentioned previously the productive forest excluded from the timber harvesting land base provides much of the area needed to meet old-forest biodiversity requirements. In the analysis however, stands in the non-contributing forest currently below 240 years of age are prevented from growing older (fire or pest activity is assumed to keep them younger than 240 years of age); therefore, these stands do not contribute to forest biodiversity requirements needing stands of at least 250 years of age. The results of this modelling intervention can be seen in the age class profile of stands in 150 years. If no disturbance had been modelled, almost all of the excluded forest would be over 240 years of age.

The age class profile of stands 150 years from now also shows that some of the timber harvesting land base has not been harvested due to forest cover constraints imposed to meet requirements for other resource values. In 150 years time, 5.3% of the stands on the timber harvesting land base are over 250 years of age, which is slightly higher (1.3%) than in the current age class profile.

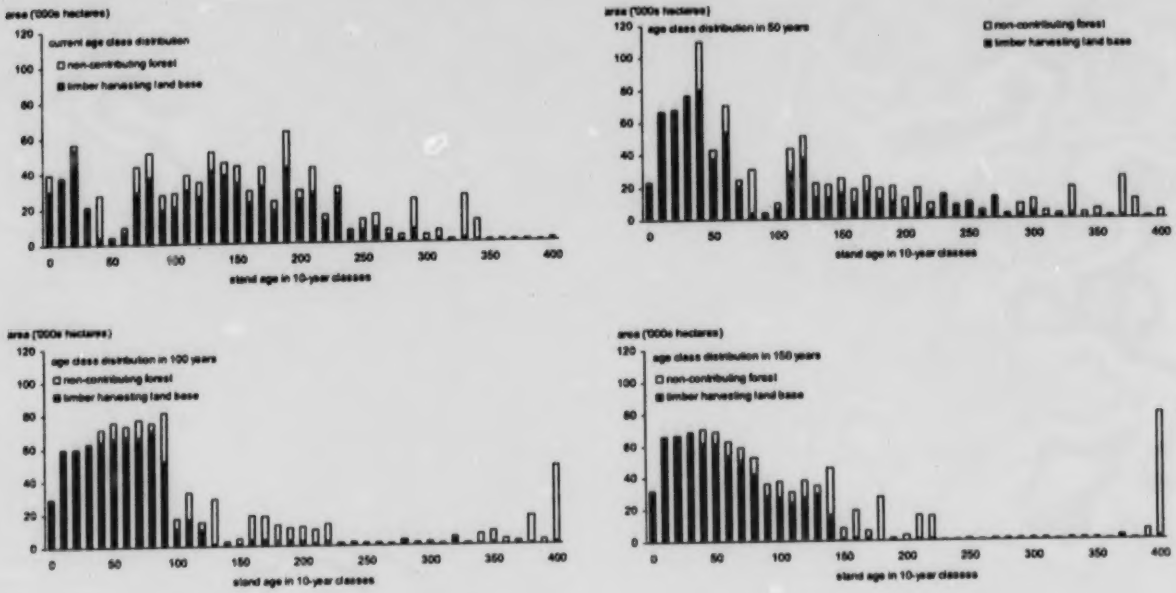

Figure 15. Changes in age composition on the productive land base over time — Morice TSA base case, 2002.

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is complicated since it must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, so that decisions we make today have not only short-term but also long-term effects beyond the life spans of current decision makers. In such a context, we cannot be certain that all the data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, (for example, timber supply), could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in other variables could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short-term than in the long-term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide a safe basis for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of a number of sensitivity analyses are discussed. Sensitivity analyses are intended primarily to test the relative change (i.e., high *versus* low sensitivity) in the harvest forecast resulting from changes in forest management assumptions and data used in the base case. Short-term refers to the first 20 years of the harvest forecast, medium-term is 21 to 100 years from now, and long-term is after 100 years from now.

5 Timber Supply Sensitivity Analyses

5.1 Alternative harvest flows

The base case harvest forecast shown in Figure 9 was developed subject to several assumptions. For example, the initial harvest level was predetermined by the current allowable annual cut.

Figure 16 compares two alternative forecasts with the base case. All inputs related to land base, growth and yield and management remain constant in all forecasts in Figure 16.

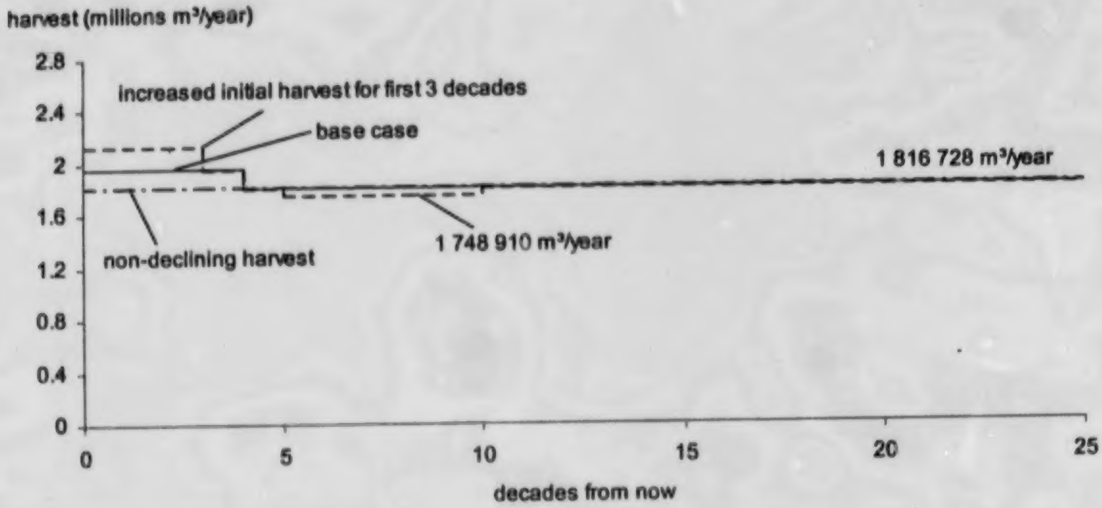

Figure 16. Alternative harvest forecasts — Morice TSA, 2002.

Increase current harvest level

- It is possible to increase the current harvest level for three decades by 8.8% to 2 133 100 cubic metres per year. The harvest level then declines to 3.0% below the base case mid-term level during decades 6 to 10.
- The total harvest is slightly higher (1.1%) than that resulting from the base case over the planning horizon.

Maximum non-declining even-flow

- The non-declining even-flow harvest level of 1 816 728 cubic metres per year can be maintained throughout the planning horizon. This harvest level in the long-term is about 0.8% greater than that for the base case.
- The short-term harvest level is 7.4% lower than that for the base case.
- The total harvest is slightly lower (1.1%) than that resulting from the base case over a 250-year planning horizon.

5.2 Uncertainty in the land base available for timber harvesting

Uncertainty in the estimated size of the timber harvesting land base is due to factors such as fluctuations in timber prices, changes in harvesting and milling technology and land-use decisions.

The timber harvesting land base has changed significantly since the last timber supply analysis for the Morice TSA. While the land base was reduced for factors such as riparian reserves, it has also increased significantly due to the reduction in the amount of land excluded for low productivity.

Currently there is no indication that the timber harvesting land base has been over- or underestimated. However, sensitivity analyses were performed to provide general information that might help evaluate the implications of any new information that becomes available before the AAC determination.

Sites with low timber productivity

The first analysis evaluates the implications of using the previous timber supply analysis definitions of low site productivity to exclude stands from the timber harvesting land base (increases the minimum site productivity requirements for spruce and balsam stands, while those for pine remain the same). If the previous definition of low site had been used in this analysis, more spruce and balsam stands would have been excluded, resulting in a timber harvesting land base of approximately 614 000 hectares or 10.2% smaller than that assumed in the base case harvest forecast.

The second scenario evaluates the outcome of reducing minimum site index requirements by two metres below those assumed in the base case, resulting in the addition of low productivity areas to the timber harvesting land base. The resulting timber harvesting land base is approximately 722 000 hectares, or 5.5% larger than that assumed in the base case harvest forecast. The harvest forecasts resulting from these changes in the assumptions for low site productivity are shown in Figure 17.

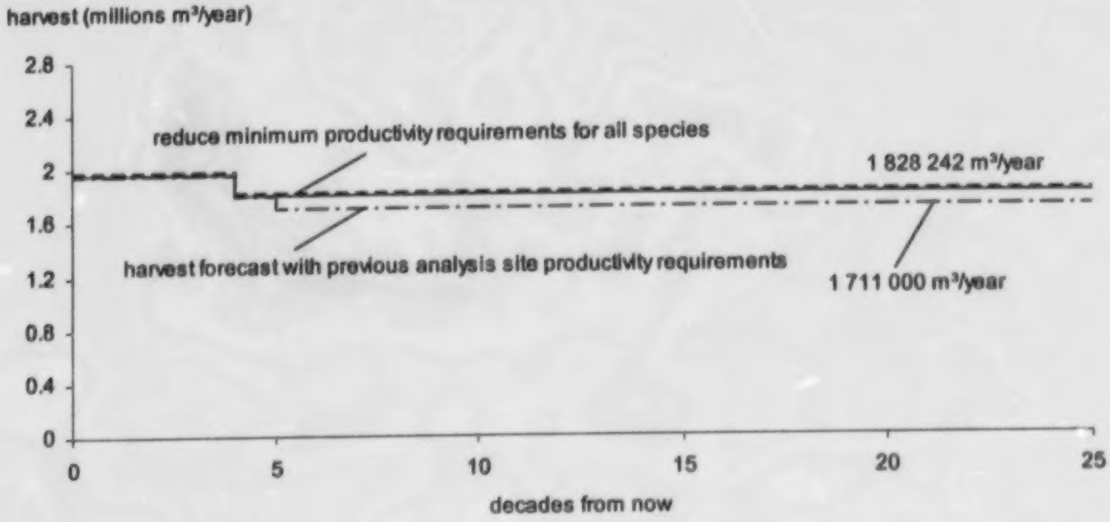

Figure 17. Land base sensitivity analysis — Morice TSA, 2002.

If the previous timber supply review definitions of low site (balsam 10.0 metres, spruce 10.5 metres) are used to exclude stands from the timber harvesting land base (10.2% decrease in area)

- There is still a sufficient area in older existing stands to support the base case harvest forecast for five decades.
- The harvest level then declines to 1 711 000 cubic metres per year, 5.1% below the base case level, after decade 5.
- The yield reduction (5.1%) is less than the percentage area reduction (10.2%) due to the low productivity (volume growing potential) of areas excluded from the timber harvesting land base.

If the site index requirements for inclusion in the timber harvesting land base are reduced by two metres (area increases 5.5%)

- The harvest level is 1.4% above that of the base case over the full 250-year forecast period.
- The yield increase (1.4%) is less than the percentage area addition (5.5%) due to the very low productivity of areas increasing the size of the timber harvesting land base.

High-cost areas

Some areas were excluded from the timber harvesting land base in the base case due to high development cost relative to the value of timber being accessed. The following scenario evaluates the outcome of including these areas in the timber harvesting land base. The resulting timber harvesting land base is approximately 710 000 hectares, or 3.8% larger than that assumed in the base case harvest forecast. The harvest forecast resulting from the addition of these high development cost areas is shown in Figure 18.

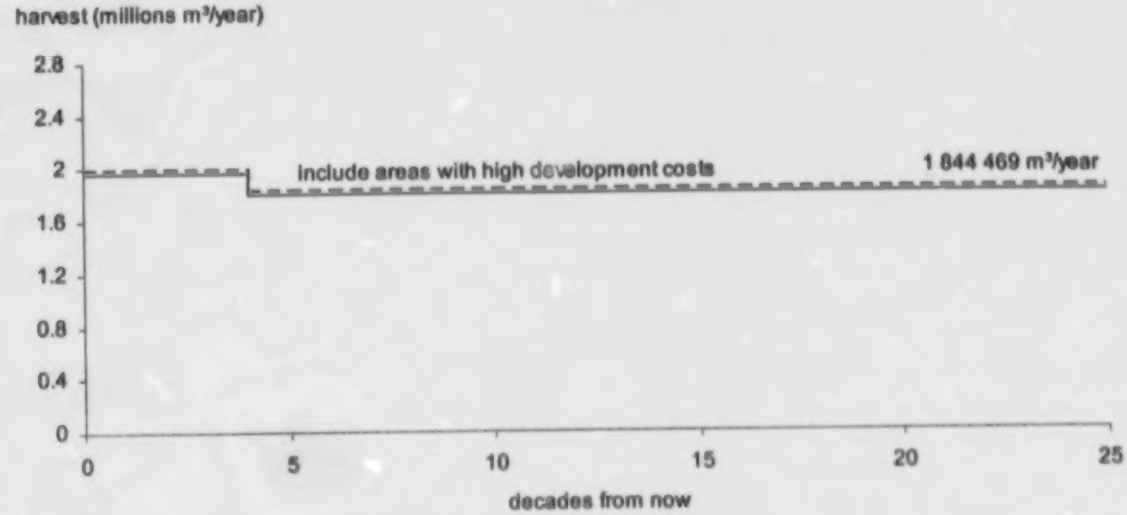

Figure 18. The effect on the harvest forecast of including high-cost areas in the timber harvesting land base — Morice TSA, 2002.

- The harvest level is 2.3% above that of the base case over the full 250-year forecast period. The short-term harvest level is 2 006 223 cubic metres per year.

Areas excluded for recreation

Areas of outstanding recreation value, and recreation areas with a high degree of environmental sensitivity, were excluded from the timber harvesting land base. The following scenario evaluates the outcome of also excluding high value recreation areas and areas requiring special management consideration from the timber harvesting land base. The resulting timber harvesting land base is approximately 648 000 hectares, or 5.3% smaller than that used in the base case harvest forecast. The harvest forecast resulting from the additional recreation area exclusions is shown in Figure 19.

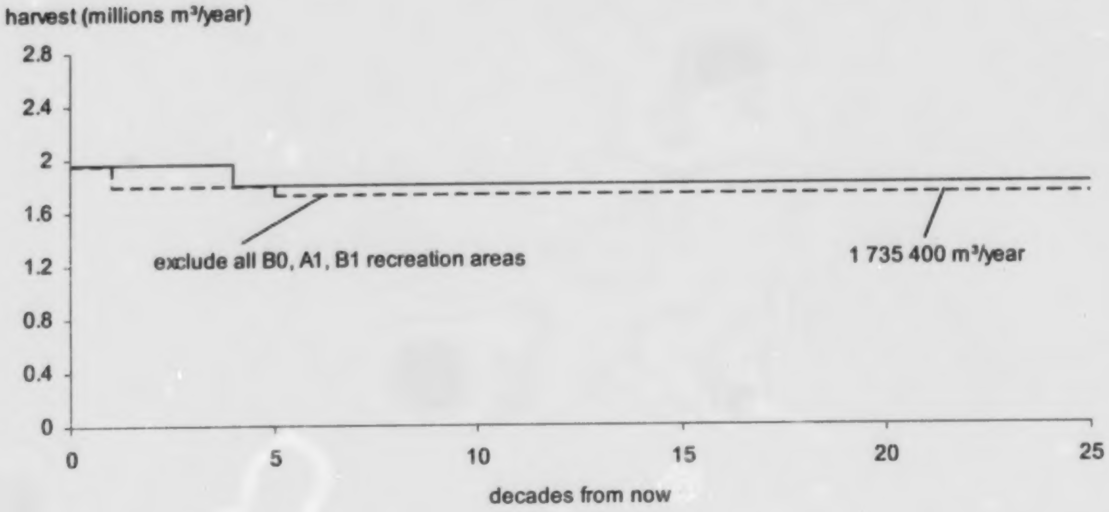

Figure 19. The effect on the harvest forecast of excluding additional areas of value for recreation — Morice TSA, 2002.

- There is still a sufficient area in older existing stands to support the base case harvest forecast for one decade.
- From the second to fourth decade the harvest level is 1 800 300 cubic metres per year, or 8.1% below that in the base case harvest.
- The long-term harvest level is 3.75% below the base case level.

5.3 Uncertainty in the estimated existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. Timber volumes are normally accurate when averaged over large areas, but may not reflect actual volumes within individual stands. Uncertainty may also arise in the estimates of volume lost to decay in older trees, of waste and breakage during harvest, and of the utilization levels practiced during harvesting. In addition, stand-level biodiversity requirements for the Morice TSA were addressed in this analysis through the removal of volume from each stand as it was harvested. Uncertainty may arise around the number and size of trees required to maintain stand-level biodiversity.

Inventory audit

During the last several years, audits of the standing volume of trees within TSAs and TFLs* were performed across the province. These audits provide an indication of how confident we can be in estimated volumes in the management unit. For the Morice TSA, initial indications from the inventory audit were that standing volumes in operable stands over 60 years of age may be overestimated by approximately 5%; however, this difference is not statistically significant at the 95% confidence level.

Given the uncertainties in existing stand volumes, the impacts of increasing and decreasing existing unmanaged stand yields (yield curves created through VDYP) by the standard +/– 10% were assessed. Figure 20 displays the results of this assessment.

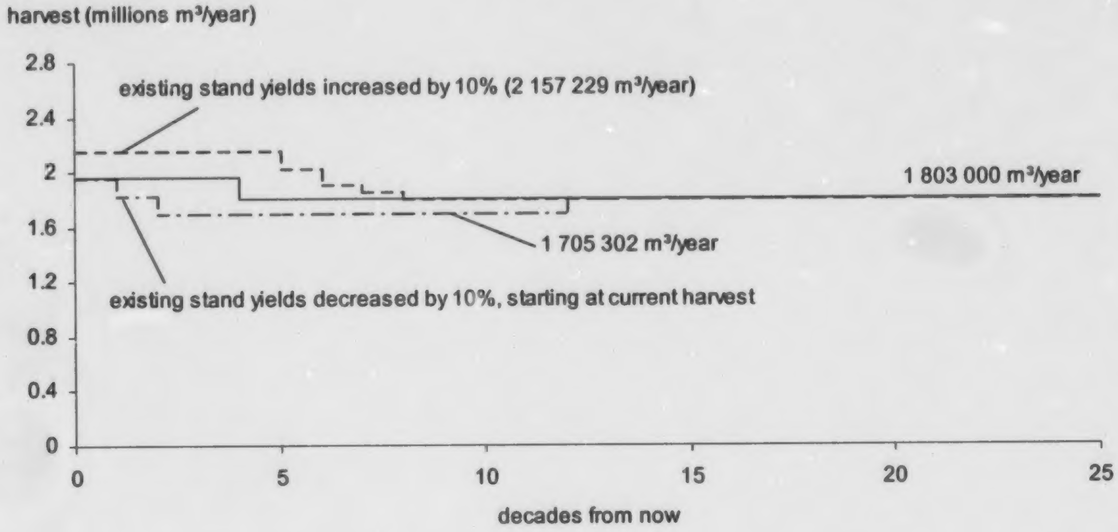

Figure 20. The effect on the harvest forecast of increasing and decreasing volume estimates for existing unmanaged stands — Morice TSA, 2002.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

If existing unmanaged stand volumes are 10% lower than assumed in base case.

- The harvest forecast is the same as the base case for the first decade.
- The harvest forecast declines to 13% below the base case level, during decades 3 and 4.
- Between decades 5 and 12, the harvest forecast is 5.4 % below the base case.
- After decade 12, the harvest forecast is the same as the base case.

If existing unmanaged stand volumes are 10% higher than assumed in base case.

- A harvest level of 2 157 229 cubic metres per year can be maintained for five decades, 10% above the short-term harvest level of the base case.
- After five decades, the harvest forecast declines for four decades to the same harvest level as in the base case.

In summary, if existing stand volumes are overestimated, the analysis shows that it is possible to maintain the current harvest level in the short term, but mid-term harvest levels may have to be reduced.

5.4 Uncertainty in the estimated managed stand yields

Uncertainty in volume estimates for managed stands exists for the same reasons listed for estimated existing stand yields (inaccuracies in the forest inventory and the growth and yield models), but also because of the limited experience and data that is available for regenerated managed stands in B.C. In this section, the timber supply effects of uncertainty associated with predicting volumes in regenerated stands is examined.

Figure 21 shows the harvest forecasts that result when managed stand volumes are increased and decreased by 10%.

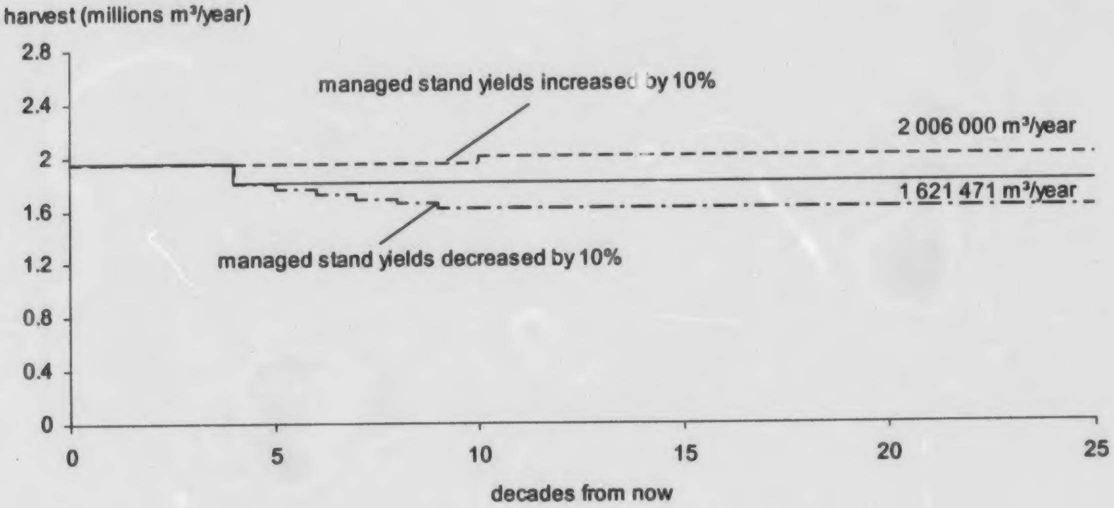

Figure 21. The effect on the harvest forecast of increasing and decreasing volume estimates for managed stands by 10%— Morice TSA, 2002.

Managed stand yields decreased by 10%

- The harvest forecast is the same as the base case for the first four decades.
- A new long-term harvest level reached in decade nine, and is 10.1% below the base case long-term level.

Managed stand yields increased by 10%

- The harvest forecast is the same as the base case for the four decades.
- Between decades 5 and 10 the harvest forecast is maintained at 1 961 117 cubic metres per year, 8.8% greater than the base case level.
- Long-term harvest level is increased 11.1% over that of the base case long-term level.

In summary changes to managed stand yields have no effect on the short-term harvest forecast for the Morice TSA. Regenerated stands are not eligible for harvest until they have reached their minimum harvestable ages, which range between 50 and 160 years. While some young existing managed stands will begin to achieve their minimum harvestable ages in a few decades, the timber inventory in the TSA is dominated by older existing stands. The harvest is not projected to be dominated by regenerated stands until about 100 years from now (see Figure 11).

5.5 Uncertainty in green-up requirements

Green-up requirements are applied to meet objectives for visual quality, wildlife, and cutblock adjacency in this analysis. Green-up requirements are defined by both the percentage of area allowed below green-up height and the number of years it takes for a stand to achieve a greened-up condition.

Percentage allowed below green-up

For the integrated resource management areas (77.9% of the timber harvesting land base), the base case included a requirement that no more than 25% of the stands on the timber harvesting land base within each landscape unit (LU) could be less than 3 metres in height. The 25% limit approximates a 4-pass harvest system. The base case harvest forecast can still be maintained if this allowable disturbance limit is decreased to 23% and applied to the integrated resource management areas, but any further reduction makes the base case harvest level unattainable. If modelling is reflective of operational reality, green-up requirements are likely constraining forest development planning in some areas of the Morice TSA. Figure 22 shows how timber supply would be disrupted if the maximum percentage of stands allowed to be below green-up height was 20% (approximates a 5-pass system) for the integrated resource management areas.

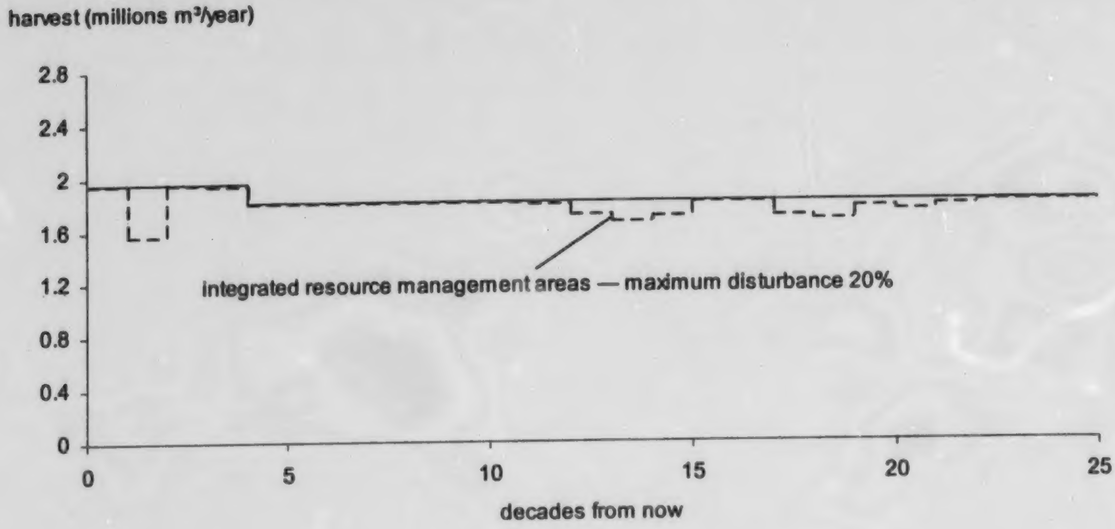

Figure 22. The effect on harvest forecast of reducing maximum allowable disturbance to 20% for integrated resource management areas — Morice TSA, 2002.

- Base case harvest level disrupted in the second decade.
- Second decade harvest level reduced 13.1% to 1 567 276 cubic metres per year

Number of years to achieve green-up

For stands to be in a greened-up condition, they must attain a pre-defined height (3 to 5 metres in this analysis). Green-up age, the age at which a stand exhibits the required height, was determined in this analysis from site productivity estimates and associated height/age relationships. The green-up period includes both the green-up age and regeneration delay*, or time to establish a stand after harvesting. Uncertainty about green-up period arises due to variation in regeneration delay and local stand growth when compared to the provincial height/age relationships.

Figure 23 shows how timber supply would change if the time for stands to achieve green-up was changed by 5 years across all management areas. It was assumed that if green-up age increased 5 years, higher volume stands would be harvested before lower volume stands to minimize the timber supply impact of the more constraining forest cover requirements. As a result, harvest priority was given to higher volume stands in this scenario. Harvest priority was not assumed to change if green-up ages decreased.

Based on current site productivity information, for a stand to achieve a green-up height of 3 metres requires approximately 18.5 years on average (varies from 14 to 27 years depending on the landscape unit) in the Morice TSA. Achieving a green-up height of 5 metres (visual and wildlife areas) requires approximately 23.5 years on average.

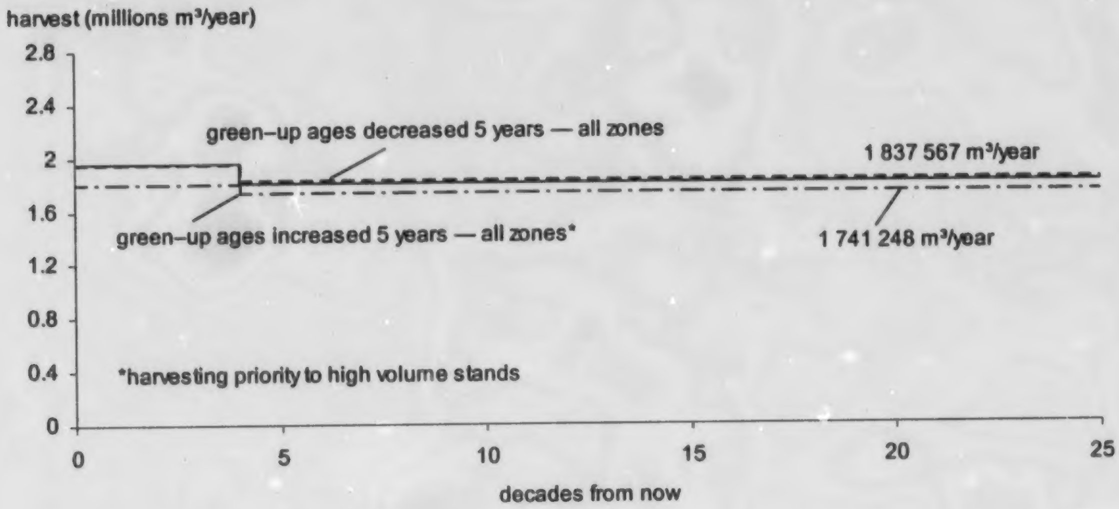

Figure 23. Harvest forecast if green-up ages were either 5 years longer or shorter than in the base case — Morice TSA, 2002.

Regeneration delay
The period of time between harvesting and the date at which an area is occupied by a specified minimum number of acceptable well-spaced trees.

Green-up ages decreased by 5 years

- The harvest forecast is the same as the base case for the first four decades.
- The new long-term level is 1.9% above the base case long-term level.

Green-up ages increased by 5 years

- The harvest forecast declines immediately to 1 808 150 cubic metres per year, 7.8% below the base case level, during decades one to four.
- The new long-term level is 3.4% below the base case long-term level.

5.6 Uncertainty about management requirements in visually sensitive areas

In the Morice TSA, visual quality assessments have been completed for the district, and objectives have been recommended but not yet established under the *Forest Practices Code*. Visual resources are currently managed using the recommended visual quality objectives, as this is consistent with the District Manager's visual management policy and with accepted practices of the district. In the Morice TSA, visual quality objectives apply to approximately 125 000 hectares (18.3%) of the timber harvesting land base, and the base case accounts for management practices in these areas.

The level of harvest from visually sensitive areas is a function of the visual absorption capacity, the visual quality rating, and the current visual condition of each area. Uncertainty about forest cover and green-up objectives for visual quality may arise from inventory and classification of land into visual absorption capacity classes, from estimates of how well different disturbance limits may meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality.

Percentage of allowable visual disturbance

In the base case, the allowable visible disturbance (percentage of stands allowed to be below green-up height) applied was at the maximum of the applicable range of allowable visible disturbances (25% for modification, 15% for partial retention*, 5% for retention* and 1% for preservation*). Figure 24 shows the results of decreasing the allowable visible disturbance for visual quality to the mid-point of the range (20% for modification, 10% for partial retention and 3% for retention and 0.5% for preservation) and to the minimum of the range (15% for modification, 5% for partial retention, 1% for retention and 0% for preservation). It was assumed in these scenarios that if allowable visual disturbance were decreased, higher volume stands would be harvested in visual areas before lower volume stands to maximize the volume attained within the allowable disturbance limits. As a result, harvest priority in visually sensitive areas is given to higher volume stands.

Partial retention VQO
*Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).*
Retention VQO
*Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).*

Preservation VQO
*Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity. (see **Visual quality objective**).*

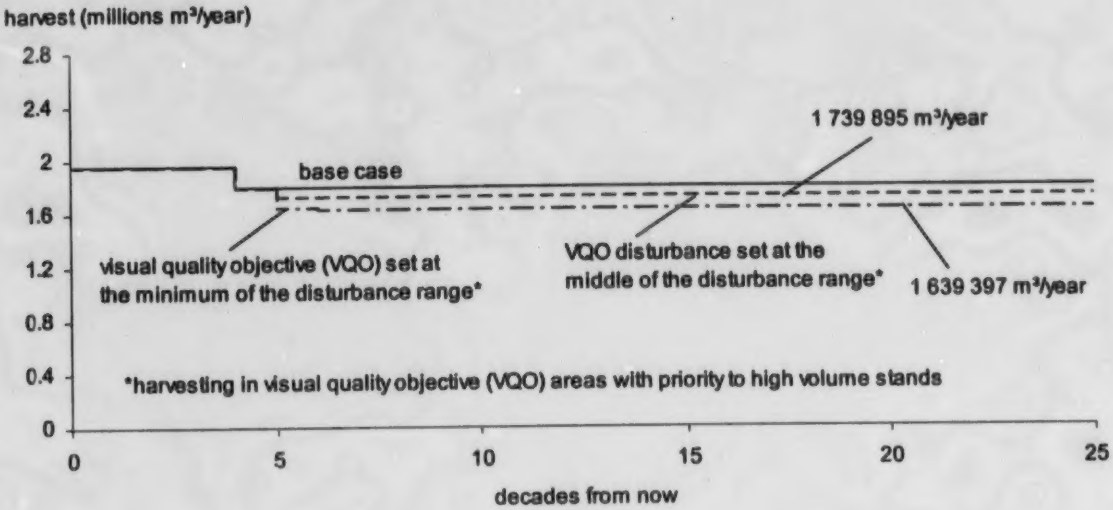

Figure 24. The effect on the harvest forecast of increasing forest cover constraints for visually sensitive areas to the mid-point and minimum of the disturbance range — Morice TSA, 2002.

Allowable visual disturbance set at mid-point of the range

- The harvest forecast is the same as the base case for first five decades.
- The long-term harvest level is reduced by 3.5%.

Allowable visual disturbance set at minimum of the range

- The harvest forecast is the same as base case for first five decades.
- The long-term harvest level is reduced by 9.1%.

Use of visual quality classes in place of recommended visual quality objectives

In the base case, the recommended visual quality objectives were used to apply allowable visible disturbance constraints to visually sensitive areas. There are also visual quality classes available for the district. These visual quality classes also define areas of visual sensitivity in the same manner as the recommended visual quality objectives.

A comparison of recommended visual quality objectives with visual quality classes shows that they cover almost identical amounts of area when compared by landscape unit and visual quality rating. Had the visual quality classes been used in place of the visual quality objectives, approximately the same amount of area in the timber harvesting land base (125 000 hectares or 18.3%) would have been considered visually sensitive, and this area would have the same visual quality ratings. The harvest level would therefore have remained the same as the base case level had the visual quality classes been used in place of recommended visual quality objectives.

5.7 Uncertainty in application of seral stage* retention recommendations

The *Forest Practices Code of British Columbia Act* (*FPC*) describes the conservation of biodiversity as an essential component of sustainable forest use. The *Landscape Unit Planning Guide (LUPG)* provides recommendations for maintaining biodiversity at both the stand and landscape levels.

Stand-level biodiversity

Stand-level biodiversity is addressed in the Morice TSA through the retention of wildlife tree patches. Based on information in the *Landscape Unit Planning Guide* the wildlife tree patch requirement is 7.25% for the Morice TSA. It is assumed one-half of this requirement will be met by forest excluded from the timber harvesting land base. The remaining 3.6% was removed from the harvest volume of each stand in the base case.

A sensitivity analysis was performed to evaluate the impact of accommodating the full wildlife tree patch requirement from within the timber harvesting land base. Figure 25 shows the resulting harvest forecast when volumes are reduced by a further 3.65%.

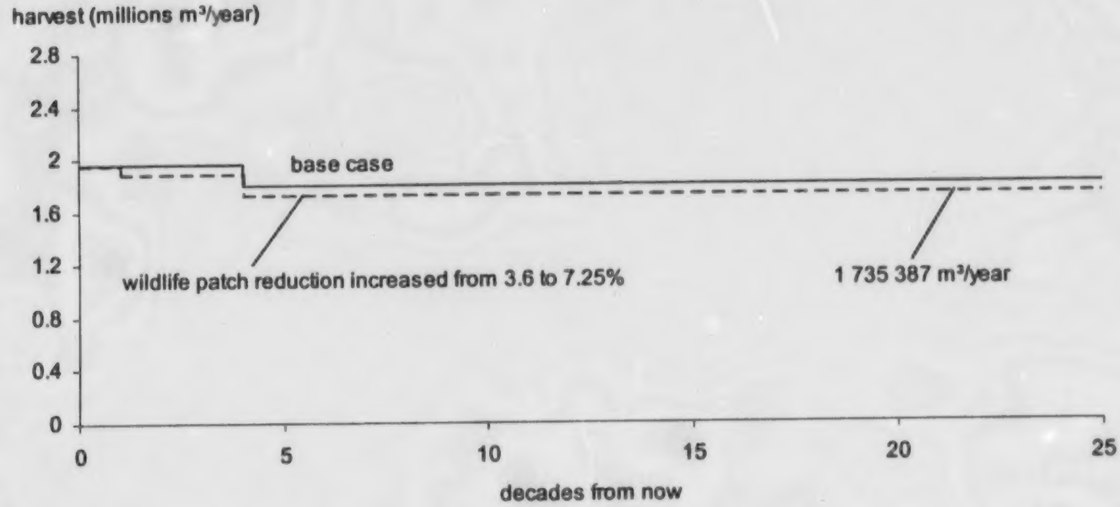

Figure 25. Wildlife tree patch reductions increased to 7.25%— Morice TSA, 2002.

- The harvest forecast is the same as base case for first decade.
- The second to fourth decade harvest level is reduced by 3.75% to 1 887 575 cubic metres per year.
- The long-term harvest level is reduced by 3.75% compared to the base case level.

Seral stages
Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.

5 Timber Supply Sensitivity Analyses

Landscape-level biodiversity

Management for landscape-level biodiversity was modelled in this analysis through the use of forest cover requirements applied to each combination of natural disturbance type (NDT)*, biogeoclimatic subzone, and variant within each landscape unit. In the base case, old-growth targets, as indicated in the *Landscape Unit Planning Guide*, were applied at the biogeoclimatic variant level within each draft landscape unit. These targets were a weighted average of the lower, medium and higher biodiversity emphasis option (BEO) targets with 45% of the area assumed to be lower emphasis, 45% assumed to be medium and 10% assumed to be high. In areas subject to low BEO, an initial reduction of the old-seral forest requirements to one-third of the target was allowed in the base case. The full requirement was met by the end of the third rotation, see Appendix A, Section A.4.10.1, "Forest cover requirements — landscape-level biodiversity" for further details.

While the approach used in the base case represents current policy for managing and modelling landscape-level biodiversity, there is uncertainty about how the recommendations in the *Landscape Unit Planning Guide* will be applied once landscape units and BEOs are declared. Draft BEOs have been assigned to the landscape units in the Morice TSA so that approximately 9.5% of the timber harvesting land base is considered as high emphasis, 53.6% medium, and 36.9% as low emphasis for biodiversity.

Although stands excluded from the timber harvesting land base can assist in meeting landscape-level biodiversity requirements, those currently below 240 years of age were not allowed to grow older (fire or pest activity assumed to keep them younger than 240 years of age) in the analysis. Therefore, for one-third of the TSA, these stands do not contribute to old-seral requirements, since old-seral is defined as over 250 years.

Three sensitivity analyses were performed to evaluate the potential timber supply impacts associated with uncertainty about landscape-level biodiversity management.

1. Change the age of stands contributing to old-seral forest requirements

   For stands to contribute to old-seral forest requirements they must attain an age of 140 or 250 years of age (depending on fire frequency of the area). If the age of stands contributing to old-seral forest requirements is decreased by 20 years, the harvest level rises above the base case level very slightly (0.4%) after decade 5. Increasing the age of stands contributing to old-seral forest requirements by 20 years reduces the harvest level 1% below the base case after decade 5.

2. Application of mature and old-seral requirements.

   In the base case harvest forecast, the mature and old-seral targets are applied only to NDT 3 (current policy). When mature and old-seral targets are applied to the entire land base (all NDTs), with an initial reduction of old-seral requirements in low-emphasis BEOs, the base case harvest targets can be met and the growing stock projections remain the same.

3. Using draft BEOs and applying early, mature and old-seral forest requirements immediately.

   Draft BEOs were used to define seral requirements. Immediate application of full early, mature, and old-seral forest requirements to all landscape units, resulting in a reduced harvest level starting in decade six (1.9%). Long-term harvest level remains 1.9% below the base case harvest level (Figure 26).

Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.

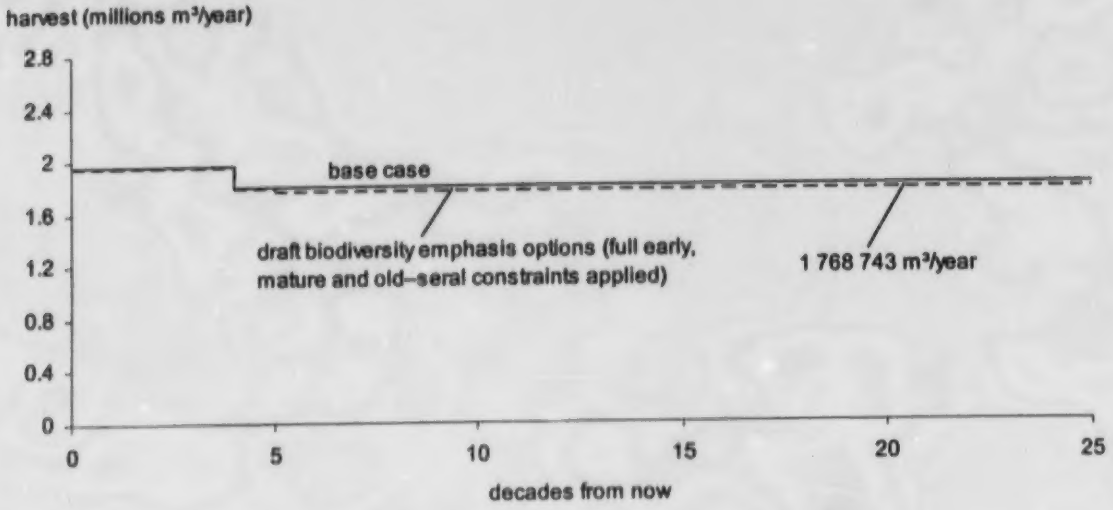

Figure 26. Harvest forecast if draft landscape unit biodiversity emphasis options are used with corresponding full early, mature and old-seral requirements — Morice TSA, 2002.

5.8 Impact of all forest cover requirements combined

Forest cover requirements are applied to maintain visual quality and wildlife values, to represent cutblock adjacency, and to maintain the amount of old forest required to protect landscape-level biodiversity. Sensitivity analyses examining individual types of forest cover requirements are presented in Section 5.5 through Section 5.7. Figure 27 shows how timber supply would be affected if all of the forest cover requirements (except stand-level biodiversity requirements) were removed simultaneously. This demonstrates the combined effect of all forest cover requirements on the timber supply.

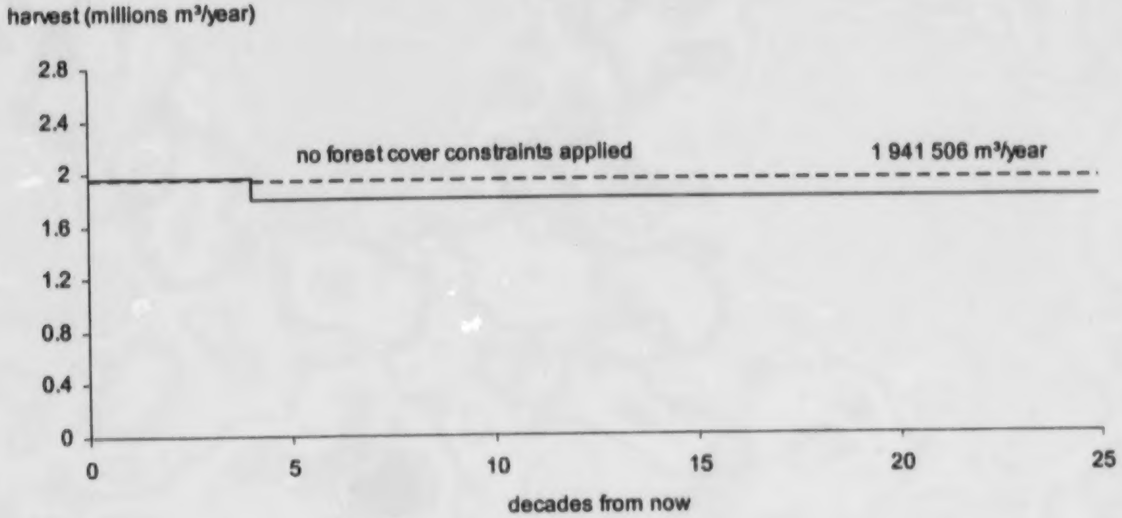

Figure 27. Timber supply forecast if not forest cover constraints are applied — Morice TSA, 2002.

- The harvest forecast is the same as the base case for the first four decades.
- The long-term harvest level increases by 7.7%.

5.9 Uncertainty in site productivity

The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years, (particularly stands less than 15 years) the growth history of trees has not yet been long enough to give accurate measurements of site productivity using conventional site index tools (site curves) and inventory estimates of height and age.

Site productivity estimates derived for older stands may also be incorrect as stands are well past the age of maximum height growth and have often been affected by disease, insects and top damage as they reach an advanced age. As a result, measurements from these trees can lead to underestimation of the growing potential of the site. If the site productivity estimates from these older stands are used to estimate the growth potential of young replacement stands, volume growth could also be underestimated.

The underestimation of site productivity of pine-dominated stands in the Morice TSA has been documented. Localized productivity adjustment equations have been developed for the majority of these pine sites (Goudie 1996). These site productivity adjustments were applied to pine-dominated stands, following harvest in the base case analysis (See Appendix A, "Description of Data Inputs and Assumptions" for more details).

Old-growth site index (OGSI)

For balsam, spruce and pine stands not covered by localized site index adjustment equations, the underestimate of site index can be addressed through the results of recent province-wide research that estimated productivity of sites currently occupied by old-growth stands. Two Old-Growth Site Index (OGSI) studies applicable to timber supply forecasting are as follows:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands, and adjacent logged and regenerated stands of the same productivity. Site indices was estimated for both stands and comparisons were made. Results are available for Douglas-fir, lodgepole pine, and interior spruce stands.

- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study was obtained from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

The results of these two studies are of interest in the Morice TSA since stands older than 140 years comprise 42% of the timber harvesting land base.

Site productivity sensitivities

To test the sensitivity of the base case harvest forecast to the uncertainty in site productivity estimates, two analyses were performed.

The first sensitivity analysis incorporated OGSI adjustments of site indices for stands older than 140 years of age whose site indices had not been adjusted using localized equations (4.6% of pine, 49.4% of spruce and 68.3% of balsam stands). Either the paired-plot (pine and spruce) or veteran-tree result (balsam) was applied, where suitable. Managed stand volume estimates for those analysis units (AU)* affected by changes in estimated future productivity were recalculated based on average adjusted site productivity. Green-up and minimum harvestable ages were also recalculated. Table 4 compares the average site index values for each analysis unit assumed in the base case (includes localized pine adjustments) with those in the OGSI sensitivity analysis.

The second sensitivity analysis demonstrates the timber supply implications of using forest inventory site index values for all stands (i.e., no site index adjustments). In this sensitivity analysis, the adjustments to pine-dominated stands assumed in the base case were not applied. Again, the yield curves fo managed pine were recalculated based on inventory site productivity. Green-up and minimum harvestable ages were also recalculated. Table 4 shows the average site index values for each analysis unit assuming the forest inventory site index for all stands.

Figure 28 shows how timber supply would be affected if forest inventory site index values had been used for all stands, or if OGSI site index values had been used for stands over 140 years of age.

Analysis unit
A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.

Table 4. Average analysis unit site indices for future managed stands based on forest inventory, localized site index adjustments and OGSI — Morice TSA, 2002

Analysis unit	Inventory site index	Base case site index	OGSI adjusted site index
Balsam — good, managed	15.9	15.9	16.7
Balsam — medium, managed	12.3	12.3	14.7
Balsam — poor, managed	9.6	9.6	13.5
Spruce — good, managed	18.4	18.4	19.3
Spruce — medium, managed	13.9	13.9	17.7
Spruce — poor, managed	10.3	10.3	17.9
Pine — good, managed	20.7	20.8	20.8
Pine — medium, managed	16.9	18.9	19.2
Pine — poor, managed	13.8	17.7	18.4
Site index average[a]	**15.0**	**16.0**	**17.9**

(a) Average value for site index for the entire TSA once all stands are harvested for the first time in the timber supply analysis.

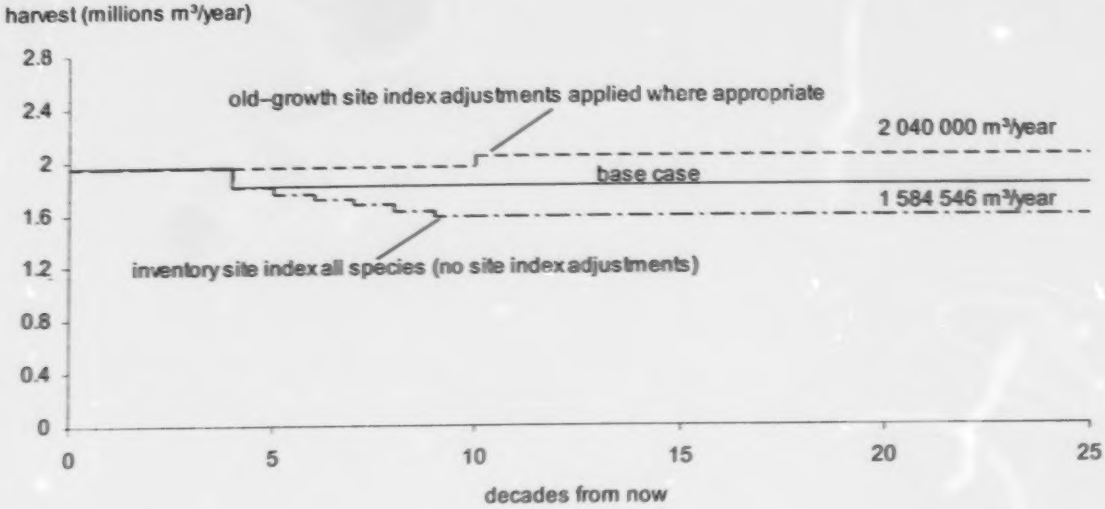

Figure 28. Harvest forecasts based on OGSI site index adjustments and inventory site index values — Morice TSA, 2002.

Harvest forecast with OGSI adjustments

- The harvest forecast is the same as base case for the first four decades.
- Between decades five and ten, the harvest forecast is maintained at 1 961 117 cubic metres per year, 8.8% greater than the base case.
- The long-term harvest level is increased by 13.1%.

Harvest forecast based on inventory site index values

- The harvest forecast is the same as base case for the first five decades.
- The harvest forecast declines by 2.5% in each of the following five decades.
- The long-term harvest level is reduced by 12.1%.

5.10 Uncertainty due to bark beetles

Mountain pine beetle (MPB) and more recently spruce bark beetle (SBB) and western balsam bark beetle (BBB) have been active in the Morice TSA. Bark beetles kill trees through a combination of larval feeding and the introduction of pathogenic fungus. These two actions effectively girdle the tree, and kill it. Older, even-aged stands are most susceptible to beetle attacks.

Harvesting activities in the Morice TSA have been targeting stands already attacked or at high risk of mountain pine beetle attack for more than 10 years and spruce bark beetle for the past 2 years. These harvesting activities appear to have kept the bark beetle epidemic in check. If the current level of infestation continues, Morice Forest District staff believe that the majority of the beetle attacked stands can be harvested within the current allowable annual cut. The remaining stands attacked by bark beetles that cannot be harvested are accounted for by an unsalvaged loss factor of 162 859 cubic metres per year for the first 50 years, and 89 572 cubic metres per year for the remaining 200 years of the forecast horizon (see Section 5.11, "Uncertainty in unsalvaged losses").

Although harvesting activities have been used effectively to manage the current bark beetle outbreak, there remains considerable uncertainly regarding the spread rate of the bark beetle epidemic. Forest health concerns are currently managed in the Morice TSA using a hazard and risk rating methodology developed in the forest district. Using this hazard and risk rating system, two scenarios were developed in the analysis to explore the implications of increased bark beetle activity in the Morice TSA.

Current harvest level directed entirely into the high-risk bark beetle stands for the next 10 years.

In the first scenario, the timber supply impacts of shifting all current harvesting into high-risk pine, spruce and extreme risk balsam stands was tested, with harvest targets specified by landscape unit for the first decade. All extreme-risk balsam, 50% of high-risk spruce and 10% or 50% of high-risk pine was targeted for harvest in the first 10 years.

Elevated harvest activity level directed entirely into the high-risk bark beetle stands for the next 10 years

In the second scenario, it was assumed that beetle activity increases in the TSA. In response, the harvest level was increased by 50% to 2 841 678 cubic metres per year, with all additional volume coming from high-risk pine stands (the harvest level remains the same as the first scenario for spruce and balsam). Again harvest targets were specified by landscape unit for the first decade with all extreme risk balsam, 50% of high-risk spruce and up to 100% of high-risk pine stands targeted for harvest in the first 10 years.

Figure 29 shows how timber supply would be affected if the current harvest level, or an elevated harvest level is directed entirely into stands at high-risk to bark beetle attack for the first 10 years. In both cases, no green-up requirements are applied for the first decade (entire land base), as the short-term harvest level could not be attained if green-up requirements were applied.

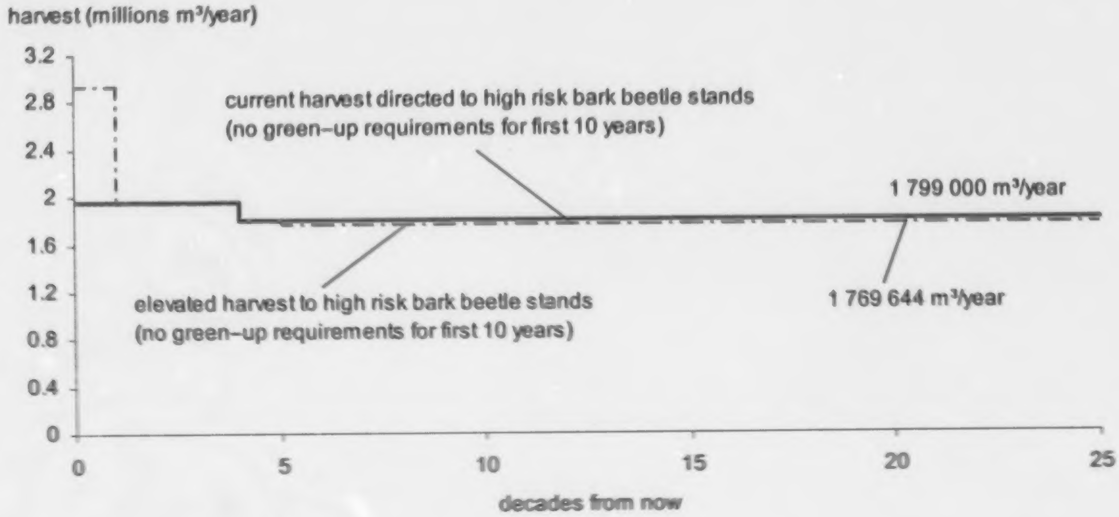

Figure 29. Harvest forecasts if the current and elevated harvest levels are directed entirely to high-risk bark beetle stands for the first decade — Morice TSA, 2002.

Current harvest level directed to high-risk bark beetle stands

- The harvest forecast is the same as the base case for first five decades.
- The long-term harvest level decreased by 0.2%.
- The growing stock is similar to base case.

Elevated harvest level directed to high-risk bark beetle stands

- The harvest forecast is increased by 50% for the first decade to 2 841 678 cubic metres per year.
- The harvest forecast is the same as base case for decades two to five.
- The long-term harvest level decreased by 1.9%.
- The growing stock is lower than that resulting from the base case over the planning horizon.
- The total harvest is slightly higher (2.4%) than that resulting from the base case over a 250-year planning horizon.

Harvest forecast for severe bark beetle activity with large unsalvaged losses

Although there is no indication that beetle activity will increase dramatically, the possibility exists. A scenario was developed to portray what might happen if beetle activity becomes severe. It was assumed in this scenario that one-third of the stands currently over 140 years of age would be killed by bark beetle activity at the beginning of the forecast and could not be harvested before the wood becomes unusable for timber production (unsalvaged loss). Since these stands would not been harvested, it was assumed that these stands would regenerate naturally for the first rotation with a 10-year regeneration delay. Timber yields were based on projections for existing unmanaged stands for the first rotation, and managed stands for subsequent rotations. The harvest forecast resulting from this severe beetle activity with large unsalvaged losses is shown in Figure 30. No green-up requirements were applied for the first five decades, as the short-term harvest level could not be attained if green-up requirements were applied.

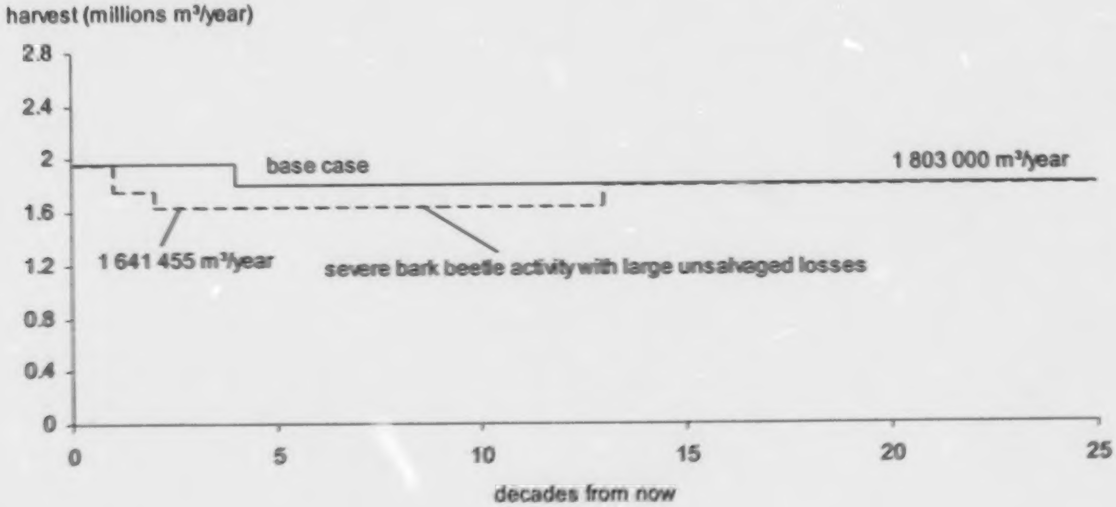

Figure 30. Harvest forecast if beetle activity becomes severe and large unsalvaged losses occur — Morice TSA, 2002.

- Volume in older existing stands is sufficient to support the base case harvest forecast for one decade. The harvest level then declines by 10% and 7% in the subsequent two decades, respectively.
- For the third and fourth decades, the harvest level is 16.3% below the base case harvest level.
- From the fifth to thirteenth decades the harvest level is 9.0% below the base case harvest level.
- After decade fourteen the harvest level returns to the base case level.

Potential volume losses if bark beetle stands remain unmanaged

If beetle activity results in stands being killed but not salvaged, volume can be lost at the time of attack and, if the site is left unmanaged, the loss of volume due to lack of management. To examine potential volume losses from stands remaining in an unmanaged condition, following natural disturbance, several pine stands that had been burned and left to regenerate naturally in the Morice TSA were examined. From this brief examination, it was observed that standing dead and down trees had interfered with regeneration on the site, both by limiting the area available for regeneration and possibly through shading of the regenerating trees. Regeneration densities were fairly low, ranging from 500 to 2000 stems per hectare, and some areas within stands remained unoccupied for up to 20 years after disturbance. Regeneration delay was variable but was approximated at 10 years.

From these observations, and with the assistance of B.C. Ministry of Forests, Research Branch staff, hypothetical stand parameters were developed to represent the naturally regenerated stands observed in the field. These parameters were then entered into the Tree and Stand Simulator (TASS) growth model and the stand growth was simulated for one rotation. Figure 31 illustrates the computer simulation of the stand at 25 years of age.

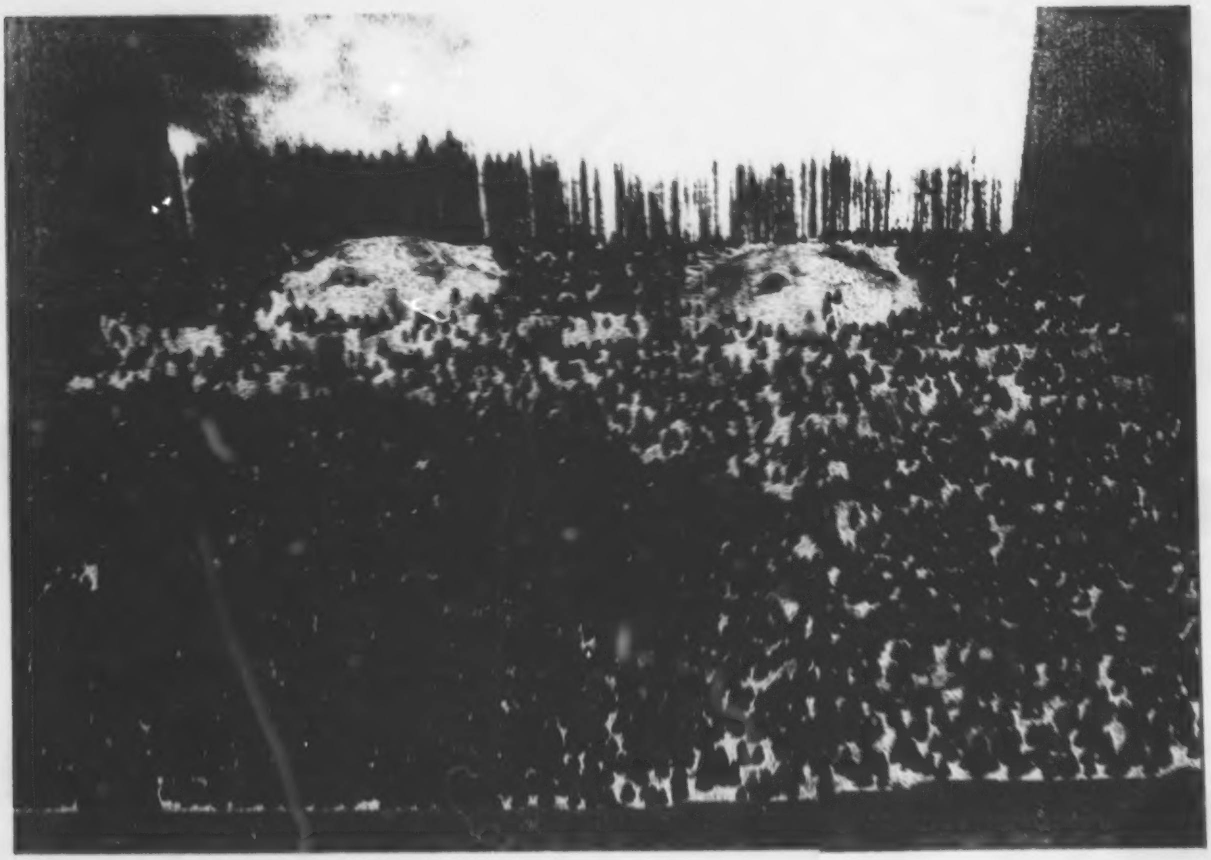

Figure 31. TASS representation of a naturally disturbed pine stand left to regenerate naturally — Morice TSA, 2002.

Figure 31 shows two large unoccupied areas in the background and scattered areas of low density over much of the stand.

Volume yields projected based on resulting assumptions were compared to volume yields using stand parameters that reflected the base case assumptions for managed stands (planting of 1500 well-distributed pine seedlings with a 2-year regeneration delay). The yield for a managed pine site (19 metres site index) was approximately 29% higher. Results from this brief study indicate that significant volume growth can be lost if management, as defined in the base case, is not practiced on beetle killed stands within the timber harvesting land base.

5.11 Uncertainty in unsalvaged losses

In the base case, the amount of volume that is lost to epidemic disease and insect outbreaks, as well as to windthrow and fire, was accounted for. If salvaged, the recovered volume is included in the base case harvest level. If volume losses are not recovered, they were accounted for as unsalvaged losses.

Unsalvaged loss estimates are based on past experience and professional judgment by district staff and are an approximation of what losses are expected to be in the future. There remains, however, a large amount of uncertainty, as losses are volatile. As an example, volumes lost to bark beetles may decrease over time as stands are harvested and regenerated to more thrifty managed stands. In the base case, unsalvaged losses were estimated at 171 959 cubic metres per year for the first 50 years and 104 572 cubic metres per year for the remainder of the 250-year forecast horizon. To accommodate these losses in the base case, the unsalvaged volume is treated as a harvest but does not contribute to timber supply, and is not reported in the harvest forecasts presented in this report. As an example, if unsalvaged losses were 5000 cubic metres per year less than predicted, the harvest could increase by 5000 cubic metres annually without any impacts to the growing stock available for harvest. Figure 32 shows how timber supply is affected by increasing and decreasing unsalvaged losses by 25%.

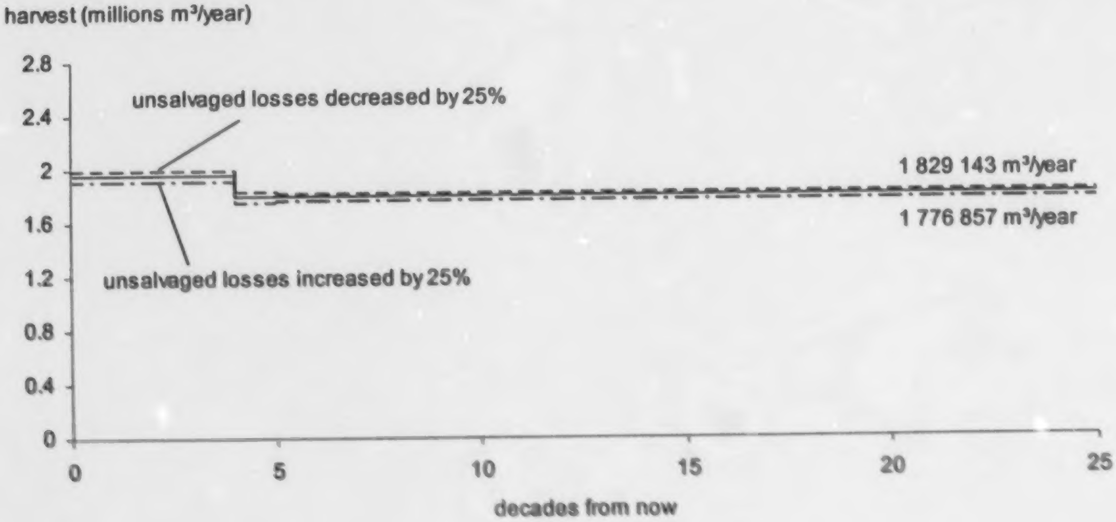

Figure 32. Unsalvaged losses increased and decreased by 25%— Morice TSA, 2002.

Decreasing unsalvaged losses by 25%

- The harvest forecast increased by 2.2% for the first four decades to 2 004 107 cubic metres per year.
- The harvest forecast increased by 2.4% for the fifth decade to 1 845 999 cubic metres per year.
- The long-term harvest level increased by 1.4%.

Increasing unsalvaged losses 25%

- The harvest forecast decreased 2.2% for the first four decades to 1 918 127 cubic metres per year.
- The harvest forecast decreased 2.4%for the fifth decade to 1 760 010 cubic metres per year.
- The long-term harvest level decreased by 1.4%.

5.12 Uncertainty in regenerated stand densities

In the base case analysis, it is assumed that all existing and future stands will be regenerated through planting to a density of 1500 stems per hectare. Although there is no indication that stands are being regenerated at a density higher or lower on average than assumed in the base case, there remains uncertainty with regard to regeneration densities. Stand density could increase through ingress of natural stems, or decrease through mortality due to pests and disease.

To understand the impact of stands deviating significantly from the 1500 stems per hectare assumed in the base case, scenarios were run to test the timber supply impact of increasing and decreasing the number of planted trees by 500 stems per hectare. These scenarios involved the generation of new managed yield curves, and the updating of minimum harvest age where necessary. Figure 33 shows how timber supply is affected by increasing and decreasing the planting densities of regenerated stands.

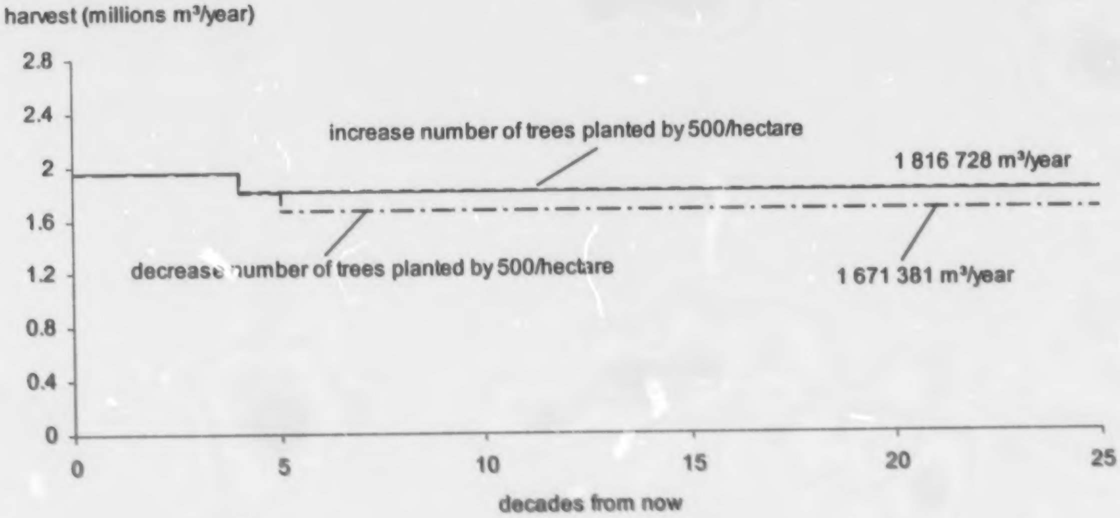

Figure 33. Harvest forecast if stands are regenerated with greater or fewer numbers of planted trees — Morice TSA, 2002.

Decrease number of planted trees by 500 stems per hectare

- The harvest forecast is the same as the base case for the first five decades.
- The long-term harvest level is decreased by 7.3%.

Increase number of planted trees by 500 stems per hectare

- The harvest forecast is the same as the base case for the first four decades.
- The long-term harvest level increases by 0.8%.

5.13 Uncertainty in minimum harvestable ages

Minimum harvestable ages are an estimate of the time needed for stands to reach a merchantable condition. They affect the time over which the harvest of existing stands must be rationed while regenerating stands grow to a merchantable age. The time at which stands will become merchantable is not known with precision because of uncertainty about the growth of regenerated stands, and an inability to foresee future conditions that will determine merchantability.

For this analysis, spruce and pine stands were considered merchantable at the age at which they attained a volume of 150 cubic metres per hectare. Balsam stands were not merchantable until they attained a volume of 200 cubic metres per hectare. See Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for the minimum harvestable ages applied in this analysis. Minimum harvestable ages are generally below the age at which average stand growth is maximized (culmination of mean annual increment (MAI)). In the short term, the average minimum harvestable age for all stands across the entire TSA is 95 years, while culmination of MAI occurs on average at 119 years of age. In the long term, the average minimum harvestable age for the entire TSA is 78 years *versus* 105 years for culmination of MAI. In the analysis, if many stands had been harvested at or near minimum harvestable age, the harvest forecast would have been impacted, as volume growth would not have been maximized. Since stands were not generally harvested in the model at their minimum harvestable age, increasing and decreasing minimum harvest age by 10 years for each analysis unit had virtually no impact on the timber supply forecast for the Morice TSA.

On the other hand, if no stands could have been harvested in the model until they had reached their maximum growth potential, the base case harvest level would have been disrupted. Figure 34 shows how timber supply would be disrupted if the minimum harvestable age had been defined by culmination of mean annual increment.

Minimum harvestable ages set at the culmination of mean annual increment age.

- The base case harvest level is met for the first eight decades.
- Timber supply disruptions occur during decades 10, 12 to 13, and decades 23 and 24.
- The growing stock is higher than in the base case in the long-term.

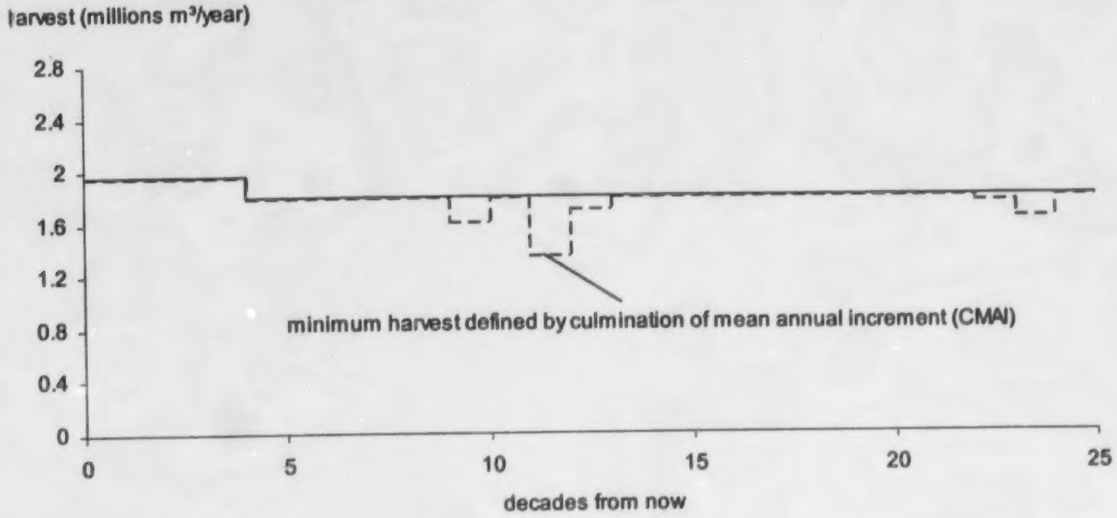

Figure 34. Harvest forecasts if minimum harvestable ages defined by culmination of mean annual increment — Morice TSA, 2002.

5.14 Uncertainty in harvest order of stands

In the base case, the priority of a stand for harvest is based on development plans, species and age. Stands proposed for harvest within forest development plans were given the highest harvest priority in the analysis. Pine stands older than 120 years and spruce stands older than 140 years were given the second highest. When the age of stands available for harvest fell below 120 years or 140 years, remaining stands above culmination of mean annual increment age were given the third highest priority as a group. Finally if harvest still cannot be met, the remaining stands above minimum harvestable age are prioritized for harvest as a group. Harvest of stands within the groups is random. This "group priority" harvest rule was created to reflect the harvesting patterns expressed in past and proposed forest development plans, and is considered a better reflection of operations in the TSA than using more standard harvest rules.

5 Timber Supply Sensitivity Analyses

To understand the impact of using this group priority harvest rule, two more scenarios were tested using the relative oldest first rule (harvest of stands the greatest number of years above minimum harvest age) and random harvest rule (random harvest of any stand above minimum harvest age). Figure 35 shows how timber supply is affected by changing stand harvesting priorities (stands within the forest development plans still harvested first).

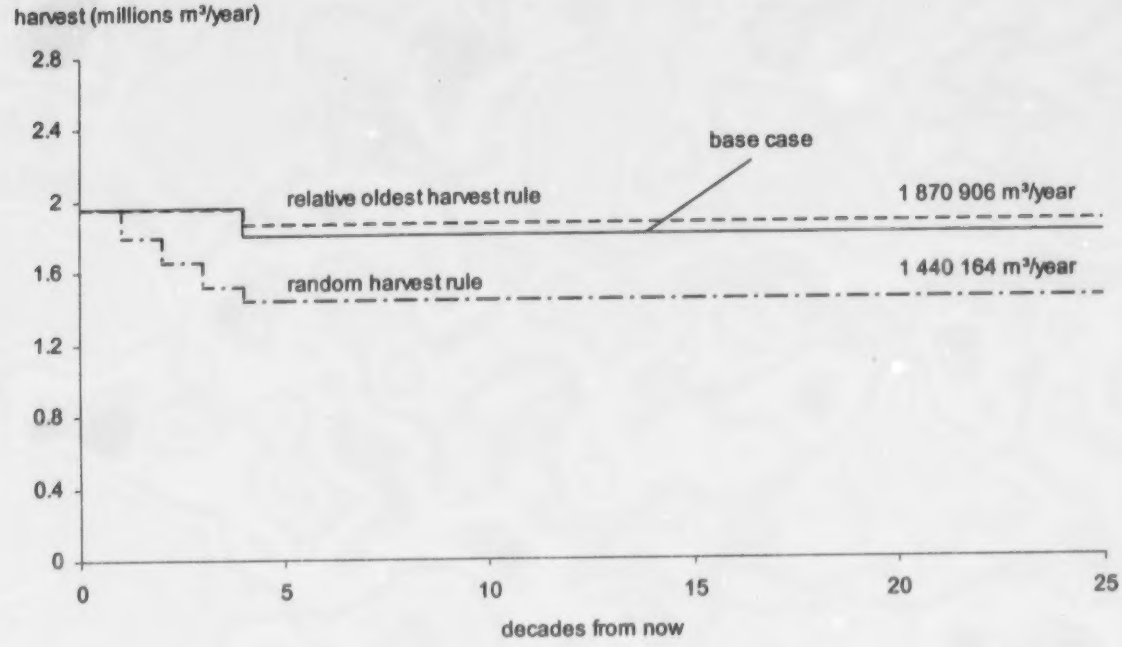

Figure 35. Alternative harvest queue (priority) rules — Morice TSA, 2002.

Relative oldest first harvest rule

- Sets the highest priority on oldest stands relative to minimum harvestable age.
- The harvest level is the same as the base case harvest level for the first four decades.
- The long-term harvest level is increased by 3.8%.
- The growing stock is reduced relative to the base case, in the medium and long term.

Random harvest rule

- Chooses stands that are older than the minimum harvestable age at random for harvesting.
- The long-term harvest level is reduced by 20.1% or 362 836 cubic metres per year.
- The growing stock is similar to the base case.

5.15 Additional sensitivity analysis that had small impacts on timber supply

1) Excluding 50% of proposed protected areas from the timber harvesting land base.

   There are ten areas proposed for protection under the protected area strategy within the TSA. They are as follows: Burnie Lakes, Nanika-Kidprice, Telkwa Range, Atna Lake, Babine Lake sites (4 small lakeshore sites), Nadina Mountain and Old Man Lake/China Nose. These areas have not been designated as official parks, but are currently deferred from harvesting. In the base case, these sites were deferred from harvest for the first 10 years but could be harvested thereafter. Areas proposed for protection cover 13 217 hectares of the timber harvesting land base. Excluding 50% of these areas from the timber harvesting land base (6609 hectares) would reduce the timber supply by approximately 1% in the medium and long term.

2) Changing the minimum utilization of standard spruce and balsam stands to a 15 cm diameter at breast height (dbh).

   In the base case it was assumed that all trees larger than 12.5 cm in diameter at breast height in pine stands, and 17.5 cm in diameter at breast height in spruce and balsam stands, would be harvested. To assess the timber supply implications of increasing the utilization of spruce and balsam stands to a minimum diameter to 15 cm, the B.C. Ministry of Forests Tree and Stand Simulator (TASS) growth and yield model was used to generate new spruce and balsam yield curves. These yield curves were then compared to those used in the base case. Yields increased from 0.2% to 3% depending on the time of harvest. It is expected that TSA wide the impact would be something less then 1% in the short, mid- and long term.

3) Uncertainty in mature forest requirements for caribou habitat.

   Caribou management areas cover approximately 29 000 hectares of timber harvesting land base in the Morice TSA. Management of caribou designated areas were represented in the base case by forest cover requirements applied to control the maximum level of disturbance (green-up) and minimum amount of mature forest. A sensitivity analysis was preformed to assess the impact of increasing and decreasing the mature forest requirement (25% of the forest > 90 years) by 10% in caribou management areas. The harvest level remained the same as that of the base case forecast indicating that the caribou mature forest cover constraint is not impacting timber supply.

5.16 Summary of sensitivity analysis impacts

Table 5 summarizes all sensitivity analyses that showed an impact on the base case harvest forecast and when the impact occurred.

Table 5. Summary of sensitivity analysis for the Morice TSA.

Report section	Description	Impact of sensitivity analysis relative to the base case		
		Short term	Medium term	Long term
5.1	Increased initial harvest for the first 3 decades	+	–	–
5.1	Non-declining harvest	–	+	+
5.2	Reduce minimum site productivity requirements	+	+	+
5.2	Previous analysis site index productivity requirements		–	–
5.2	Including high-cost areas in timber harvesting land base	+	+	+
5.2	Excluding more recreational areas	–	–	–
5.3	Existing yields increased 10%	+	+	
5.3	Existing yields decreased 10%	–	–	
5.4	Managed yields increased 10%		+	+
5.4	Managed yields decreased 10%		–	–
5.5	Decreasing maximum allowable disturbance on IRM area	–	–	–
5.5	Green-up age increased 5 years — all zones	–	–	–
5.5	Green-up age decreased 5 years — all zones		+	+
5.6	Allowable visual disturbance set at mid-point of range		–	–
5.6	Allowable visual disturbance at minimum point of range		–	–
5.7	Wildlife tree patch reduction increased to 7.25%	–	–	–
5.7	Application of draft BEOs with all seral requirements		–	–
5.8	No forest cover constraints applied		–	–
5.9	Harvest forecast based on inventory site index values		–	–
5.9	Harvest forecast with OGSI site values		+	+
5.10	Current harvest level directed at bark beetle stands		–	–
5.10	Elevated harvest level directed at bark beetle stands	+	–	–
5.10	Harvest forecast for severe bark beetle activity	–	–	–
5.11	Decreasing unsalvaged losses	+	+	+
5.11	Increasing unsalvaged losses	–	–	–
5.12	Decrease number of trees planted		–	–
5.12	Increase number of trees planted		+	+
5.14	Relative oldest first harvest rule		+	+
5.14	Random harvest rule	–	–	–
5.15	Excluding 50% of areas proposed for protection		–	–
5.15	Increasing utilization in spruce and balsam stands	+	+	+

Note: Short term refers to the first 20 years of the harvest forecast, medium term is 21 to 100 years from now, and long term is after 100 years from now.

6 Summary and Conclusions of the Timber Supply Analysis

The results of this timber supply analysis suggest that, given data and management assumptions that reflect current information and practices, the current allowable annual cut in the Morice TSA of 1 961 117 cubic metres per year can be maintained for forty years. After forty years, the projected harvest level of 1 961 117 cubic metres per year declines by 8.2%, and reaches a steady level of 1 803 000 cubic metres per year. A series of sensitivity analyses showed that data and management uncertainties affect timber supply projections to varying degrees, some with positive impacts and others with negative impacts.

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the harvest forecast relies on harvests from these stands for the next 100 years. Lower estimates of timber volumes in existing stands, increases in the time taken to achieve green-up, reduced maximum allowable disturbance in the integrated resource management areas and increased bark beetle activity, all had large effects on the base case short-term harvest levels (next 20 years). An audit conducted in 1998 indicated that, when the operable portion of the TSA (approximately the timber harvesting land base) is considered, volumes estimated using inventory information were 5% higher than estimates based on ground measurements; however, the difference was not statistically significant. Sensitivity analysis showed that if existing stand volumes were 10% lower than the inventory estimates and the current harvest level is maintained for one decade, timber supply will decline to 13% below the base case level during decades 3 and 4, and to 5.4% below the base case level between decades 5 and 12. After decade 12, when the harvest is mainly from managed stands, timber supply returns to the same level as in the base case.

The length of time taken to achieve green-up conditions and the maximum level of allowable disturbance also affected short-term timber supply. Sensitivity analysis suggested that if green-up heights were achieved five years later than assumed in the base case, the current harvest level could not be maintained. The harvest level would be decreased by 7.8% for the first four decades, and by 3.4% thereafter. As well, if the maximum allowable disturbance is reduced for the integrated resource management areas to 20%, the harvest is reduced in the second decade by 13.1%.

Increased bark beetle activity could also impact the short-term harvest level in two ways as follows: by necessitating an increase in harvest to remove stands at risk to bark beetle; or larger unsalvageable losses of existing stand volumes. Harvest in high-risk bark beetle stands could be increased by 50% for the first decade if green-up requirements were ignored for that time period. The harvest projection would then be the same as the base case from decades 2 to 5, and thereafter decline to 1.9 % below the base case level. If bark beetle activity becomes severe, and the harvest level is not increased, large unsalvaged volume losses would likely result. Then timber supply would decrease in the second decade and remain well below the base case level, before recovering to the base case level from decade 14 on.

Medium-term (21 to 100 years from now) timber supply is affected by many of the factors tested through sensitivity analysis. Because the harvest forecast is fairly flat over the entire forecast horizon, (one 8.2% drop in decade 5), changes in factors that alter either the total amount of existing volume, or the ability to access existing and managed volume during the first 100 years will affect medium-term timber supply. The medium-term is affected by changes in the following: the size of the timber harvesting land base; volumes from existing stands; volumes from managed stands; green-up requirements; allowable visual disturbance; stand and landscape biodiversity; site productivity estimates; bark beetle activity; regeneration density; rules governing which stands are selected for harvesting; and the standards used to define merchantable trees.

Uncertainty in managed stand volumes caused changes to medium- and long-term timber supply. If managed stand volumes were 10% higher than estimated in the base case, the mid-term timber supply would increase and long-term timber supply would be 11.1% higher. If managed stand volumes were 10% lower than estimated, the mid-term timber supply would be reduced and long-term timber supply would be 10.1% lower than the base case.

6 Summary and Conclusions of the Timber Supply Analysis

Site productivity estimates caused changes to medium- and long-term timber supply by affecting volume estimates of regenerating stands and the size of the timber harvesting land base. If old-growth site productivity adjustments were used for regenerated stands, the mid-term timber supply would increase, and long-term supply would be 13.1% higher. If inventory site index was applied to all stands and used to estimate volumes of regenerating stands, the mid-term timber supply would decrease and long-term supply would be 12.1% lower.

Had the minimum site index criteria been used from the previous Morice TSA analysis to define and exclude non-merchantable stands, the timber harvesting land base would have been reduced by 10.2 % and, after decade 5, timber supply would be 5.1% lower. Another factor with potentially large impacts on medium- and long-term timber availability is the rule used to set harvest priority. The analysis showed significant impacts when merchantable stands (older than the minimum harvestable age) were chosen at random for harvesting, rather than the priority harvest rule based on development plans, species and age used in the base case. While it is unlikely that stands will be harvested at random above their minimum harvest age, the harvest level is sensitive to the order in which stands are harvested.

Recommended visual quality objectives cover 18.3% of the timber harvesting land base. The assumption in the base case was that the disturbance in the visual quality objective (VQO) areas would be at the maximum of the allowable range. Medium- and long-term timber supply would be reduced by approximately 9.1% if allowable visual disturbance was reduced to the minimum value of the acceptable range. If the allowable disturbance was in the middle of the range, medium- and long-term timber supply would be 3.5% below the base case.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all of the above factors with the exception of changes to existing stand volumes. In conclusion, this analysis indicates that based on current inventory, growth and yield, and forest management information, timber harvests in the Morice TSA can be maintained at the current level for 40 years. The analysis indicates that several factors related to the current forest inventory and management regime could affect timber supply. However, other than the possibility that site indices for old-growth stands may be underestimated, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis.

7 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. This socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Morice TSA to the level of activity that could be supported as the timber supply moves towards its long-term harvest level.

The socio-economic analysis examines the short- to long-term harvest levels as projected in the base case harvest forecast. The base case is intended to reflect current forest management practices; consequently, the socio-economic analysis does not evaluate alternative management scenarios.

The socio-economic analysis includes:

- a profile of the current socio-economic setting;
- a description of the Morice TSA forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

7.1 Current socio-economic setting

7.1.1 Overview

The socio-economic analysis focuses on the timber supply from the Morice TSA, located on the western edge of British Columbia's central Interior Plateau in the south-eastern portion of the Prince Rupert Forest Region. The TSA is bordered to the west by the Cascade Mountains and to the south by Tweedsmuir Provincial Park, and is administered from the Morice Forest District office in Houston. The total size of timber supply area is about 1.5 million hectares.

The area includes the community of Houston and the smaller communities of Topley and Granisle. The Highway 16 corridor and the area from Owen Lake to Francois Lake support a number of farms and ranches.

7.1.2 Population and demographic trends

According to the 1996 Census, the population of the TSA decreased significantly between 1991 and 1996, from 6,100 to 5,573 (see Table 6). Most of the decline occurred as a result of the closing of the Bell Copper mine in Granisle, when reserves were exhausted in mid-1992. By 2005, the population of the TSA is expected to be back up to about 5,800 people.

The TSA includes the community of Houston (1996 population of 4,105) and the smaller communities of Granisle (465) and Topley.

Table 6. Population trends in the Morice TSA (1991–2005)

Community	1991	1996	2000 (estimated)	2005 (estimated)	% change/year 1996-2005
Houston	3,735	4,105	4,205	N/A	
Granisle	825	465	435	N/A	
Other	1,540	1,005	1,020	N/A	
Morice TSA	6,100	5,575	5,660	5,800	0.4

Source: Census of Canada 1991, 1996; B.C. Stats.

7.1.3 Economic profile

Located at the confluence of the Morice and Bulkley rivers, Houston is the main service and administrative centre in the Morice TSA. The community also boasts the world's largest fly-fishing rod — a 60-foot tall, 800-pound structure — as a tribute to the hundreds of fly-fishing enthusiasts who visit the "World Steelhead Capital" every year.

Houston was named after John Houston, a colourful B.C. politician and newspaperman who never actually lived in the town, but had his name chosen in a contest in 1910. Until that time the town was known as "Pleasant Valley". The community developed as a rail-tie-cutting centre for the Grand Trunk Pacific Railway in the early 1900s and became an incorporated municipality in 1957 with a population of 612.

Along with significant forestry activity, Houston is the base community for Huckleberry Mines Ltd. The mine site is located 120 kilometres south-west of Houston and employs about 150 people (not all from the Morice TSA) in the production of copper, silver, gold and molybdenum. The mine has been in operation since October 1997. Agriculture also remains an important source of local revenue. The area just north of Houston has some of the best soils in the Bulkley-Nechako region and currently is mainly employed in the production of beef cattle and dairy products.

Figure 36 illustrates the percentages of total employment by industry sector that exists in the Morice Forest District in 1996, which is the latest year this data is available.

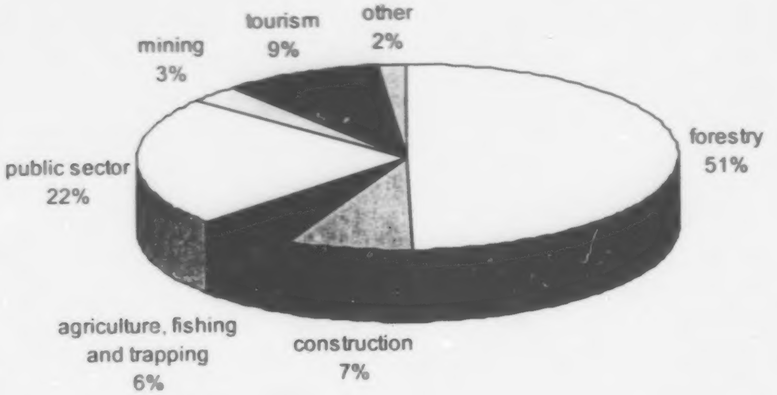

Figure 36. Major employment by sector for the Morice TSA, 1996.

Source: The 1996 Forest District Tables, April 1999, Ministry of Finance and Corporate Relations.

Notes: "Forestry" consists of harvesting related activity and manufacturing. "Other" consists of finance, insurance, real estate and other business services. "Public Sector" consists of local and provincial government, health and education.

7 Socio-Economic Analysis

During 1996, direct forestry sector employment in the Morice TSA amounted to approximately 1,100 jobs — more than half of TSA total employment. The forestry sector also supports numerous jobs in the region through logging companies and employees purchasing goods and services from other local businesses. Aside from the impacts noted above, spin-off employment is also an important indicator of the basic role forestry has in the economy. Each 100 direct forestry jobs in the Morice TSA are estimated to support a further 20-40 indirect and induced jobs*[1], depending on the type of direct activity (logging, silviculture or wood products manufacturing). In comparison, the roughly 60 mining and mineral processing jobs support approximately 25–30 additional positions, while the public sector and tourism sector supports six to 24 additional positions per 100.

A breakdown of 1996 income dependencies (including direct, indirect and induced [spin-off] impacts) confirms forestry's importance to the TSA. During 1996, $48 million of basic, before-tax income (52% of the TSA total)[2] was forestry dependent (including TSA and non-TSA timber supply).

7.2 Morice TSA forest industry

7.2.1 Current allowable annual cut

The allowable annual cut (AAC) in the Morice TSA is 1 985 815 cubic metres, down marginally from 2 000 000 cubic metres pre-1996 (due to issued woodlots). The AAC is apportioned into a number of licence types as outlined in Table 7. Two companies have replaceable forest licences in the TSA, accounting for 90% of the total AAC (1 778 000 cubic metres). The remainder is apportioned among several other forms of tenure including the Small Business Forest Enterprise Program (SBFEP).

Table 7. Morice TSA allowable annual cut apportionment, by licence type in 1996

Licence types	AAC (m^3/year)	Percentage of total (%)
Forest licences	1 778 380	89.6
Small Business Forest Enterprise Program (SBFEP)	184 870	9.3
Forest Service Reserve	16 750	0.8
Woodlot licence	5 815	0.3
Total	1 985 815	100.0

Source: Ministry of Forests (2001).

The annual amount of harvested volumes are permitted to vary from licensed volumes (under the licence cut control provisions) enabling the licensee to respond to market conditions and other factors. As well, the harvest of diseased, dead or damaged trees is usually attributed to the Forest Service Reserve portion of the AAC.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

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(1) The 1996 Forest District Tables, April 1999, Ministry of Finance and Corporate Relations.

(2) Ibid.

7.2.2 Morice TSA harvest history

The actual annual harvest level is an important indicator of forestry activity in the timber supply area. While the AAC is the allowable harvest level, the actual volume of timber harvested in a particular year indicates the economic activity supported by the timber supply area. If actual annual harvest levels are consistently less than the AAC, then the economic activity is below its full potential.

The actual volume of timber harvested each year in the TSA makes up about 25% of the total harvest in the Prince Rupert Forest Region (7.8 million cubic metres) which in turn accounts for about 11% of the total provincial Crown harvest (69 million cubic metres [2000-01]). Table 8 summarizes the volume of timber harvested in the TSA from 1997 to 2000. Approximately 1,440 full-time harvesting and processing positions would normally be associated with the annual harvest of the Morice TSA.

Table 8. Morice TSA volumes billed, by licence type, 1997–2000

	Cubic metres per year (m³/year)				
Licence type	**1997**	**1998**	**1999**	**2000**	**Average 1997-2000**
Forest licences	1 694 914	1 726 743	1 934 167	1 644 369	1 750 048
Small Business Forest Enterprise Program (SBFEP)	150 409	165 240	125 073	206 196	161 730
Licences to cut	71 929	18 786	15 440	3 876	27 508
Other	4 391	15 964	24 251	74 877	29 871
Total	1 921 643	1 926 733	2 098 931	1 929 318	1 969 157

Source: Ministry of Forests.

"Other" consists of cutting permits such as rights-of-way, road permits and other special allowances.

7.2.3 Morice TSA major licensees

Houston Forest Products

Houston Forest Products, owned by West Fraser Mills Ltd. (West Fraser), has a replaceable forest licence to harvest 713 896 cubic metres per year in the Morice TSA. West Fraser also has a number of other licences in the province amounting to over 4 million cubic metres per year. Table 9 outlines Houston Forest Products' harvest activity in the TSA and its year 2000 employment levels for TSA operations.

Table 9. Houston Forest Products harvest and direct employment statistics

Licence allowable annual cut (AAC)	713 896 cubic metres
2000 harvest	719 232 cubic metres
1997 – 2000 average harvest	694 565 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	225
Processing	220

Note: The employment figures relate to the volumes harvested from the Morice TSA land base only.

West Fraser began operations in 1955 and is now an integrated forest products company producing dimension lumber and related solid wood products, fibreboard, pulp, linerboard, kraft paper and newsprint. The company also owns and operates a chain of retail home improvement stores in Canada.

West Fraser has interests in nine sawmills that produce dimensional lumber and by-product wood chips in British Columbia. West Fraser's sawmills sell lumber products to retail and wholesale customers and lumber brokers. In 1998, 72% of lumber sales were to customers in the United States and 25% to Canadian customers, who resold a significant portion into the United States. Asian and other customers accounted for the remaining 3% of sales. Most of the sales to North American customers are shipped by rail directly from the sawmills. The remainder is shipped by truck or by water through West Fraser's deep-sea terminal at Kitimat.

West Fraser has a 50% joint venture interest with Weldwood of Canada Ltd. in a sawmill and planer mill complex in Houston. The facility has an annual lumber capacity of 130 million board feet. Wood chips from the plant are trucked to West Fraser's pulp and paper mill in Kitimat, where they support additional employment. In 2000, West Fraser's processing operations at Houston employed approximately 275 people.

7 Socio-Economic Analysis

Canadian Forest Products Ltd.

Canadian Forest Products Ltd. (Canfor) has a replaceable forest licence in the Morice TSA to harvest 1 064 484 cubic metres of timber per year. Canfor has numerous other tenures throughout the province totalling over 8 million cubic metres per year. Table 10 outlines Canfor's recent harvest activity and 1997-2000 average employment levels associated with its Morice TSA operations.

Table 10. Canfor harvest and direct employment statistics

Licence allowable annual cut (AAC)	1 064 484 cubic metres
2000 harvest	1 086 973 cubic metres
1997 – 2000 average harvest	1 170 729 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	340
Processing	240

Note: The employment figures relate to the volumes harvested from the Morice TSA land base only.

Canfor currently operates 11 sawmills, two pulp facilities, a pulp and paper mill, a plywood plant, two remanufacturing plants and a chip mill in the province. Most products are sold in the United States, Canada and Asia.[3]

In 1999, Canfor acquired Northwood Inc. from the Mead Corporation of Dayton, Ohio, and Nexfor Inc. of Toronto. The purchase included the lumber and chip facility in Houston, one of the world's largest sawmill complexes. The mill covers approximately nine hectares, handles virtually any log size, and produces mostly kiln-dried dimension lumber in lengths from eight to 24 feet. The chipping plant, built in 1995, converts waste wood — decayed and otherwise flawed timber — into chips for pulp and paper production.

The acquisition of Northwood doubled Canfor's annual pulp production to over one million tonnes and boosted its softwood lumber capacity by one-third to 2.7 billion board feet, making Canfor one of Canada's largest softwood lumber producers.

The Houston mill produces 350 million board feet annually and was the first in North America to be certified under the Council of Forest Industries to grade stamp lumber for export to Japan. This "JAS Certification" places Canfor in the forefront in developing a wider market potential in Japan.

Other licensees

Other licensees in the TSA are mainly comprised of Small Business Forest Enterprise Program (SBFEP) participants with a total AAC apportionment of 184 870 cubic metres. From 1997 to 2000, SBFEP harvests averaged 161 730 cubic metres annually, which supported roughly 150 direct harvesting, silviculture and processing person-years.

Other processing facilities

In addition to the mills discussed previously, in 1998, two remanufacturing plants operated in Houston. Pleasant Valley Remanufacturing, with 25 employees, and Corwood Timber Products, with a dozen employees, take what otherwise would be waste wood and turn it into usable products.

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(3) Canfor Corporation, Annual Report.

7.2.4 Forestry sector employment summary

In this section, the preceding harvesting and employment information is considered in the development of employment coefficients used to project future employment levels. For this purpose, the forestry sector has been divided into the following three sub-sectors:

- harvesting and other woodlands-related employment such as log salvage, log scaling and planning;
- silviculture activity including all planting and other basic and intensive operations; and
- primary timber processing employment.

Harvesting and silviculture employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the most closely tied to the AAC; consequently, harvest level changes will affect this sub-sector first, and in close to the same proportions.

The silviculture sub-sector is less linked to the current level of harvest, since silviculture activities occur at least three to six years after harvesting. Silviculture activity is divided into basic and enhanced work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced, or intensive, silviculture includes spacing, fertilization and pruning*. In the Morice TSA, as in the rest of the province, licensees are responsible for basic silviculture on areas harvested under forest licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, which is normally completed by silviculture contractors.

Forest Service employment

The Morice TSA is administered by the Morice Forest District office in Houston. Currently, about 50 people work in the Houston office although these jobs are not included in the analysis of forestry sector impacts. Most Ministry of Forests employment is considered to be linked to forest management rather than to the harvest level.

Morice TSA forestry employment and employment coefficient summary

Table 11 summarizes employment supported by the 1997-2000 average harvest in the Morice TSA, and the corresponding employment coefficients. The employment and employment coefficients are separated into two groups:

- TSA employment and employment coefficients, which comprise residents of the Morice TSA who are employed within the Morice TSA; and
- Provincial employment and employment coefficients, which comprise all forestry sector employment in the province that relies on the Morice TSA timber supply, including both residents of the Morice TSA and those who live elsewhere.

Calculations have been made for both groups to identify the importance of the forestry sector within the Morice TSA and to highlight the contribution of the Morice TSA's forestry sector to the provincial economy.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Table 11. Morice TSA employment and employment coefficients

Activity	TSA person-years	TSA coefficients	Provincial person-years	Provincial coefficients
Harvesting	405	0.20	449	0.23
Silviculture	169	0.09	188	0.10
Processing	451	0.23	815	0.41
Total direct	1,025	0.52	1,452	0.74
Indirect + induced	311	0.16	1,731	0.88
Total employment	1,336	0.68	3,183	1.62

Note: Employment estimates are person-years based on average 1997-2000 employment levels and the average 1997-2000 harvest of 1.97 million cubic metres. Person-years do not indicate individual jobs. Wood products transport, and road building and maintenance are included in indirect estimates.

More detailed information regarding employment coefficients is presented in Appendix B, "Socio-Economic Analysis Background Information."

7.2.5 Morice TSA employment income

From 1998 to 2000, the average annual income for direct forestry sector employees was approximately $49,500 (depending on the type of forestry activity); and $30,800 for indirect and induced employment (in $1999). Based on these averages, current harvesting, silviculture and processing of timber from the Morice TSA generate an estimated $72.1 million in direct wages and salaries and $53.3 million in indirect and induced wages and salaries annually throughout the province (see Table 12).

Table 12. Average annual direct and indirect and induced incomes and total employment income, 1997-2000

	Average annual income ($ 1999)	Total annual income ($ millions)	Total income ($/'000s m^3/year)
Direct	49,500	72.0	36,550
Indirect + induced	30,800	53.3	27,050
Total income		125.3	63,600

Source: Statistics Canada, Survey of Employment Payrolls and Hours.

7.2.6 Provincial government revenues

Provincial government revenues from the forestry industry include stumpage, royalties and rent payments; other taxes such as logging, corporate capital, sales, property and electricity; and income taxes from direct, indirect and induced employees.

From 1997 to 2000, average stumpage and rent payments for Crown timber in the Morice TSA were about $97.3 million per year. Forest and corporate taxes and revenues generated $16.3 million, while employment supported by the Morice TSA timber harvest accounted for $11.7 million in provincial income taxes (see Table 13).

Table 13. Average annual provincial government revenues, 1997–2000

	Average annual revenue 1997-2000 ($ 1999 millions)	**Revenue ($/'000s m³)**
Stumpage, rents and royalties	97.3	49,412
Industry taxes	16.3	8,125
Provincial income tax	11.7	5,941
Total government revenues	125.3	63,478

7.3 Socio-economic implications of the base case harvest forecast

The base case harvest forecast suggests that a harvest level of 1.96 million cubic metres per year, the current AAC adjusted to account for recently issued woodlots, could be maintained for the next four decades. After that, a steady long-term harvest level of 1.8 million cubic metres per year is projected. The socio-economic analysis focuses on the base case harvest level changes in the short- to mid-term period, and considers:

- the implications of alternative harvest levels for both the Morice TSA and the province;
- possible impacts on the communities within the TSA;
- timber requirements of processing facilities within the Morice TSA; and
- regional timber supply implications.

The socio-economic analysis considers the average levels of forestry activity that the base case harvest forecast could support, assuming that employment changes by the same percentage as the harvest level, and that the proportion of harvesting, processing and silviculture employment remains the same. Since the analysis also assumes that the types and proportions of products manufactured remain constant, it does not attempt to predict how timber flows, technology or product lines may change in response. The analysis provides an indication of the size of impacts to expect within a constantly changing socio-economic environment.

Employment and income impacts are divided into direct, indirect and induced components; the sum of all the components is the total impact. Direct impacts reflect harvesting, silviculture and processing activity. Indirect impacts are the result of direct businesses purchasing goods and services, and induced impacts are the result of direct and indirect employees spending their incomes on consumer goods and services.

Table 14 estimates the range of impacts that the base case harvest forecast may have on employment and income. Ranges are used to reflect the uncertainties associated with workforce mobility given the availability of employment insurance and social assistance payments and their dampening effects in the nearer term. The lower end of the range reflects the diminished short-term impacts that result because employment insurance and social assistance provide income support to workers who would otherwise consider leaving the TSA if timber availability were reduced. The upper end of the range represents long-term impacts when workers, eventually, do leave an area and local spending patterns are more fundamentally affected. In reality, a combination of these two scenarios — some workers staying and accessing social assistance payments, and some more immediately mobile — is more likely to occur.

7.3.1 Short- and long-term implications of alternative harvest levels

Morice TSA employment and income impacts

For accounting purposes, TSA employment and income impacts include only those workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment supported by Morice TSA timber processed at mills outside the TSA. Table 14 indicates the employment and income that could be supported within the Morice TSA by the base case harvest forecast. If fully harvested and processed, the base case harvest level of 1.96 million cubic metres could support approximately 1,020 person-years of direct employment and another 310 indirect and induced person-years of employment within the timber supply area. Approximately $41 million ($1999) total after-tax annual income would be supported by the Morice TSA timber supply.

Provincial employment and income impacts

Provincial employment and income impacts include all forestry sector employment supported by the timber harvested from the Morice TSA, regardless of the location of the impacts. If the base case harvest level of 1.96 million cubic metres is fully harvested and processed, the Morice TSA could support at least 1,446 person-years of direct forestry employment and a further 1,723 person-years of indirect and induced employment across the province and contribute $92 million ($1999) in total after-tax annual income.

Provincial government revenue impacts

Based on current tax and stumpage rates, the base case harvest level of 1.96 million cubic metres per year has the potential to provide approximately $112 million annually to the provincial government ($1999), roughly $1 million less than the current harvest level provided (assuming current taxation and stumpage rates do not change). It should be noted that the difference between the current and base case harvest level, 24 698 cubic metres of recently issued woodlots, remain in the community fibre supply with expected employment and revenue gains not included in these totals.

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Table 14. Socio-economic impacts of the base case harvest forecast — Morice TSA, 2002

		Base case harvest forecast	
	Current AAC	**Years 0-40**	**Years 40+**
Timber supply ('000s m³/year)			
AAC	1 985	1 961	1 803
Harvest level (average 1997-2000)	1 970		
Cumulative change		– 19	– 139
Morice TSA			
Employment		(person-years)	
Direct	1,030	1,020	958
Indirect + induced	313	310	291
Total	1,343	1,330	1,249
Cumulative change in total person-years		– 104 to 78	– 167 to 5
Net employment income		($ 1999 millions)	
Direct	34.2	33.9	31.8
Indirect + induced	7.4	7.4	6.9
Total	41.6	41.2	38.7
Cumulative change in total income		– 2.6 to 1.8	– 4.5 to 0
Province (includes Morice TSA)			
Employment[a]		(person-years)	
Direct	1,460	1,446	1,358
Indirect + induced	1,740	1,723	1,618
Total	3,200	3,169	2,976
Cumulative change in total person-years		– 314 to 253	– 460 to 73
Net employment income[b]		($ 1999 millions)	
Direct	51.2	50.7	47.6
Indirect + induced	41.3	40.9	38.4
Total	92.5	91.6	86.0
Cumulative change in total income[c]		– 7.6 to 5.8	– 11.9 to 0
Provincial government revenues		($ 1999 millions)	
Provincial income tax	10.6	10.5	9.9
Stumpage and rent	88.0	87.1	81.8
Other B.C. revenues	14.7	14.6	13.7
Total B.C. revenues	113.3	112.2	105.4
Cumulative change in total revenue		– 1.7 to – 0.4	– 7.5 to – 6.2

(a) Provincial employment includes both Morice TSA employment and employment supported outside the TSA by Morice TSA harvested timber.

(b) Estimates for current employment and income differ from those in Tables 11, 12 and 13. Employment figures in Table 14 are based on the current AAC of 1 985 815 cubic metres, while the figures in Table 11 are based on the 1997–2000 average harvest level of 1 969 157 cubic metres. Income figures in Table 14 are net of taxes while those of Tables 12 and 13 are gross income from the 1997–2000 average harvest level.

(c) The ranges for employment and income changes take into consideration employment insurance and other social assistance programs. The range's upper limit is based on the assumption that all those who are unemployed will leave the TSA. The lower limit is based on the assumption that employment insurance and other social assistance payments will reduce the induced impacts of a lower harvest level.

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The ranges for employment and income changes take into consideration employment insurance and other social assistance programs. The range's upper limit is based on the assumption of full and immediate labour force mobility. The lower limit is based on the assumption that, in the short term, employment insurance and other social assistance payments will lower the induced impacts of a reduced harvest level.

7.3.2 Community-level impacts

The impacts of short- and long-term changes in timber supply occur within a growing region. The more diversified the region, the less effect changes in any one sector will have on the regional economy. For less diversified and more remote communities, any reduction to timber supply may lead to population declines and alter the structure of the local economy.

In 1996, the forestry sector provided 51% of basic employment in the Morice TSA. Given that, changes to the timber supply would be expected to have a fairly significant impact on the overall economic trends of the region. It is anticipated, however, that some processing components of the forestry industry will increase in the TSA over the longer term as value-added and other secondary processing facilities mitigate reductions in timber supply.

7.3.3 Nature, production capabilities and timber requirements of processing facilities

The base case harvest forecast for the Morice TSA indicates that the timber supply could be maintained for roughly the next 40 years after which time it is forecast to decline by 8% in decade 5 Assuming that the reduction in the timber supply is spread evenly among tenures, a 8% reduction may not have a significant effect on local processing activity. Furthermore, it is anticipated that value-added and other secondary processing activities will mitigate the long-term reduction. And finally, it is pertinent that the outlook for the timber supply projections do not include the woodlot volume that remains to be processed in the local area.

7.3.4 Regional timber supply implications

The future of the Morice TSA timber supply is also important to primary processing facilities in the other regional TSAs (particularly Lakes and Bulkley). In the larger Prince Rupert Forest Region, the previous timber supply review led to a reduction in the coniferous AAC of 6.8%, or about 600 000 cubic metres. In two to three decades, the annual timber supply from the Prince Rupert Forest Region may fall by another 5%, or 400 000 cubic metres, assuming that current forest management considerations remain the same. However in the short term, harvest levels are temporarily higher in the adjacent Lakes TSA due to the epidemic infestations of mountain pine beetles (MPB).

Any mill-level impacts will not occur solely as a result of changes in the volume of timber harvested from the TSAs in which they are located; they will also result from harvest changes that occur across the region. It is not possible to predict, however, the specific mills, communities and/or local areas that will be most affected, or if new value-added processing operations will offset or exacerbate some of the changes.

7.4 Summary

The forestry sector is an important source of employment and income for the Morice TSA. Between 1997 and 2000, approximately 50% of the TSA's basic employment resulted from the forestry sector. Except for the Fort St. James and Mackenzie TSAs, the Morice TSA's economy is the most forestry dependent and one of the least diversified in the province.

Approximately 80% of the Morice TSA's processing requirements (2.5 million cubic metres per year) are supported by the AAC (1 985 815 cubic metres). If the AAC is fully harvested and processed, it can support approximately 1,460 person-years of direct employment and a further 1,740 indirect and induced jobs across the province.

7 Socio-Economic Analysis

The base case harvest forecast for the Morice TSA indicates that the timber supply could be roughly maintained for the next 40 years. In the fifth decade, the harvest level is projected to decline to an annual 1.80 million cubic metres, which could reduce direct employment by about 100 person-years, and indirect and induced employment by a further 100-150 person-years. At that time the Morice TSA, would support approximately 1,358 person-years of direct employment and 1,618 person-years of indirect and induced employment province wide. It is anticipated that value-added and other secondary processing activities will mitigate the long-term reduction. Finally, it is pertinent that the outlook for the base case forecast does not include the annual woodlot harvest totaling about 38 900 cubic metres per year, which nonetheless remain to be processed in the local area.

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Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Analysis unit	A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Clearcut harvesting	A harvesting method in which most trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Culturally modified tree	A tree or a remnant of a tree with evidence of traditional aboriginal forest use.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

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Employment coefficient	The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Employment multiplier	An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.
Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.
Forest Ecosystem Network (FEN)	An area that serves to maintain or restore the natural connectivity within an area.
Forest cover objectives	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).
Forest inventory	An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Forest Practices Code	Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Forest type	The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

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Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Land and Resource Management Plan (LRMP)	A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

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Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, reaches its maximum is called the culmination age (CMAI). Harvesting all stands at this age results in a maximum average harvest over the long term.
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.
Non-merchantable forest types	Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well-spaced trees of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Old seral	Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

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Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Partial retention VQO	Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-year.
Preservation VQO	Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity. (see **Visual quality objective**).
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Regeneration delay	The period of time between harvesting and the date at which an area is occupied by a specified minimum number of acceptable well-spaced trees.
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.

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Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Table Interpolation Program for Stand Yields	A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.
Timber harvesting land base	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) that is not harvested.
Variable Density Yield Prediction model	An empirical yield prediction system supported by the Ministry of Sustainable Resource Management, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed species composition.

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Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

In March of 2001 a data package for the Morice Timber Supply Area timber supply review was released for public review. As a result of public input, a number of data and management assumptions have been revised. This appendix presents the revised information used to produce the base case timber supply analysis.

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Morice TSA timber supply analysis. This information represents current forest management in the area. Current management is defined as the set of land-use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced are not included in this appendix. The purpose of the timber supply review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

A.1 Inventory Information

Table A-1. Inventory information

Data	Source	Vintage	Scale
Forest cover (FC1/FIP)	MoF	1993, 1995, 1998	1:20,000
TSA boundaries	MoF (District)	1999	1:50,000
Forest health hazard	MoF (District)	1998	1:50,000
Telkwa caribou herd recovery area	MELP	1997	1:50,000
Landscape unit boundaries	MoF/MELP	1998	1:20,000
Biogeoclimatic ecosystem classification (BEC)	MELP	1998	1:250,000
Natural disturbance types	MoF (District)	1998	1:250,000
Protected area strategy (Phase II)	MELP	1998	1:50,000
Operability	MoF (District)	1998	1:20,000
Local resource use plan (LRUP) boundaries	MoF (District)	1995	1:20,000
Roads	MoF (District)	1999	1:20,000
Road buffers	MoF (District)	2000	1:20,000
Stream and wetland classification	MoF (District)	1999	1:20,000
Stream and wetland riparian buffers	MoF (District)	2000	1:20,000
Visual landscape inventory	MoF (District)	1999	1:20,000
Recreation features	MoF	1998	1:20,000
Five-year Forest Development Plans (details proposed and approved blocks)	District & licensees	1999	1:20,000
District woodlots	MoF (District)	1998	1:20,000
District agricultural leases	MoF (District)	1998	1:20,000

Data source and comments:

Forest cover

Disturbance information is updated on the forest cover (FC1/FIP) maps to 1993 (13 maps), 1995 (36 maps) and 1998 (93 maps). Forest cover disturbance was updated in the base case to 1998 or 1999 using Licensee Forest Development plans (excluding woodlots).

TSA boundaries

The TSA boundaries are done to Terrain Resource Inventory Mapping (TRIM) heights of land and were created by the district data hub.

A.1 Inventory Information

Telkwa caribou herd recovery area

The boundaries of the Telkwa caribou herd recovery area were used to apply forest cover constraints in the base case.

Landscape unit boundaries

Twenty-two draft landscape units have been delineated to TRIM heights of land in the Morice TSA.

Biogeoclimatic mapping

Biogeoclimatic ecosystem mapping has been updated since the 1996 timber supply analysis.

Protected area strategy

Ten proposed protected areas have been deferred from harvest for the first decade of the base case analysis.

Operability

Identifies stands above the 1360 metres contour.

Local resource use plans — boundaries

Morice LRUP Zone A area has forest cover requirements applied in the analysis.

Road and riparian buffers

Riparian reserve, road, trails and landings areas have been delineated and spatially buffered for this analysis.

Visual landscape inventory

Recommended visual quality objectives are used to apply forest cover requirements in the analysis.

Recreation features

Provincially significant designation (A0) and areas of high environmental sensitivity (Er1) are excluded from the timber harvesting land base.

Forest development plans

The Forest Development Plans in the database show the most recent submission for existing and proposed harvest blocks. Existing harvest blocks were used to update forest depletions and proposed harvest blocks are used to prioritize harvest.

Woodlots

As of 2000, there are a total of 32 approved woodlot licences with corresponding allowable annual cut (AAC) allocations. Woodlots are excluded from the timber harvesting land base since their cut does not contribute to the AAC of the TSA.

Agricultural leases

Mapping identifies agricultural leases in the Morice TSA.

A.2 Zone and Analysis Unit Definitions

A.2.1 Management zones (groups)

Management zones represent areas with distinct management emphasis. For example, a zone may be based on a harvesting system, silviculture system, visual quality objective or wildlife consideration. Some areas may be subject to more than one management objective. Grouping enables the analyst to apply overlapping constraints to such areas.

Table A-2. provides general descriptions of the management objectives and related information to be tracked in the analysis. The non-contributing forest (i.e., forested land not available for timber harvesting) is included for consideration in attaining forest cover objectives for landscape-level biodiversity and visual quality. Further information on the forest cover requirements to be applied to these areas can be found in Section A.4.10, "Forest cover requirements."

Table A-2. Objectives to be tracked

Objectives	Inventory definition	Function
Landscape-level biodiversity requirements	Non-standard mapped layer.	Application of forest age related biodiversity targets at the landscape unit/BEC zone-variant level. All Crown forest included. Reporting purposes to track old-seral targets.
Recommended visual quality objectives	Standard mapped layer.	To maintain forest cover in areas identified as visually sensitive consistent with each visual quality objective and to report on cover status.
Integrated resource management area	Areas within the timber harvesting land base not subject to other specified management objectives.	Allow application of green-up criteria by landscape unit.
Morice River LRUP Zone A	A specific area within the timber harvesting land base.	Application of forest cover requirements to limit harvesting to address forest health and fire management issues.
Telkwa caribou herd recovery area	Non-standard mapped layer.	Application of forest cover requirements to forested land within the caribou management zone.
Draft landscape units	Non-standard layer.	Reporting purposes. Provide an assessment of the total forest by landscape unit. All Crown forest included.

Data source and comments:

See Section A.1, "Inventory information," for the sources of the management zone information mentioned above.

A.2.2 Analysis unit characteristics

An analysis unit represents forest stands with similar tree species (as indicated by the inventory type group), similar timber growing capability (as indicated by the site index in the forest inventory file) and similar forest management regimes. Each analysis unit was assigned its own timber volume projection (growth curve).

Yield tables for existing natural stands were derived using the variable density yield prediction (VDYP) yield model. Yield tables for recent plantations and future stands were derived using the table interpolation program for stand yields (TIPSY), batch version.

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A.2 Zone and Analysis Unit Definitions

Table A-3. Definition of analysis units

Analysis unit	Analysis unit number	Inventory type groups	Species	Inventory site[a] index range (m @50 years breast height age)	Age (years)
	Existing natural stands				
Balsam–good–thrifty	111	18, 19, 20	B, BH, BS	> 14	35-140
Balsam–good–old	112	18, 19, 20	B, BH, BS	> 14	>140
Balsam–medium–thrifty	121	18, 19, 20	B, BH, BS	11–14	35-140
Balsam–medium–old	122	18, 19, 20	B, BH, BS	11–14	>140
Balsam–poor–thrifty	131	18, 19, 20	B, BH, BS	< 11	35-140
Balsam–poor–old	132	18, 19, 20	B, BH, BS	< 11	>140
Spruce–good–thrifty	211	21, 24, 25, 26	S, SB, SPl, SDec	> 16	35-140
Spruce–good–old	212	21, 24, 25, 26	S, SB, SPl, SDec	> 16	>140
Spruce–medium–thrifty	221	21, 24, 25, 26	S, SB, SPl, SDec	12–16	35-140
Spruce–medium–old	222	21, 24, 25, 26	S, SB, SPl, SDec	12–16	>140
Spruce–poor–thrifty	231	21, 24, 25, 26	S, SB, SPl, SDec	< 12	35-140
Spruce–poor–old	232	21, 24, 25, 26	S, SB, SPl, SDec	<12	>140
Pine–good–thrifty	311	28, 30, 31	Pl, PlS, PlDec	> 19	35-140
Pine–good–old	312	28, 30, 31	Pl, PlS, PlDec	> 19	>140
Pine–medium–thrifty	321	28, 30, 31	Pl, PlS, PlDec	15–19	35-140
Pine–medium–old	322	28, 30, 31	Pl, PlS, PlDec	15–19	>140
Pine–poor–thrifty	331	28, 30, 31	Pl, PlS, PlDec	< 15	35-140
Pine–poor–old	332	28, 30, 31	Pl, PlS, PlDec	< 15	>140
	Regenerated stands				
Balsam–good–existing	113	18,19,20	Balsam leading	> 14	6-34
Balsam–med–existing	123	18,19,20	Balsam leading	11–14	6-34
Balsam–poor–existing	133	18,19,20	Balsam leading	< 11	6-34
Spruce–good–existing	213	21, 24, 25, 26	Spruce leading	> 16	6-34
Spruce–med–existing	223	21, 24, 25, 26	Spruce leading	12–16	6-34
Spruce–poor–existing	233	21, 24, 25, 26	Spruce leading	< 12	6-34
Pine–good–existing	313	28, 30, 31	Pine leading	> 19	6-34
Pine–med–existing	323	28, 30, 31	Pine leading	15–19	6-34
Pine–poor–existing	333	28, 30, 31	Pine leading	< 15	6-34
Balsam–good–future	114	18,19,20	Balsam leading	> 14	1-5
Balsam–med–future	124	18,19,20	Balsam leading	11–14	1-5
Balsam–poor–future	134	18,19,20	Balsam leading	< 11	1-5
Spruce–good–future	214	21, 24, 25, 26	Spruce leading	> 16	1-5
Spruce–med–future	224	21, 24, 25, 26	Spruce leading	12–16	1-5
Spruce–poor–future	234	21, 24, 25, 26	Spruce leading	< 12	1-5
Pine–good–future	314	28, 30, 31	Pine leading	> 19	1-5
Pine–med–future	324	28, 30, 31	Pine leading	15–19	1-5
Pine–poor–future	334	28, 30, 31	Pine leading	< 15	1-5

a) Inventory site index used to delineate stands into analysis units. Site index adjustments then applied to pine leading stands.

Analysis unit legend: 1st digit = species group (balsam=1; spruce=2; pine=3)
2nd digit = productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing managed = 3, future managed=4).

A.2 Zone and Analysis Unit Definitions

Table A-3. Definition of analysis units

Analysis unit	Analysis unit number	Inventory type groups	Species	Inventory site[a] index range (m @50 years breast height age)	Age (years)
	Existing natural stands				
Balsam–good–thrifty	111	18, 19, 20	B, BH, BS	> 14	35-140
Balsam–good–old	112	18, 19, 20	B, BH, BS	> 14	>140
Balsam–medium–thrifty	121	18, 19, 20	B, BH, BS	11–14	35-140
Balsam–medium–old	122	18, 19, 20	B, BH, BS	11–14	>140
Balsam–poor–thrifty	131	18, 19, 20	B, BH, BS	< 11	35-140
Balsam–poor–old	132	18, 19, 20	B, BH, BS	< 11	>140
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Spruce–good–old	212	21, 24, 25, 26	S, SB, SPl, SDec	> 16	>140
Spruce–medium–thrifty	221	21, 24, 25, 26	S, SB, SPl, SDec	12–16	35-140
Spruce–medium–old	222	21, 24, 25, 26	S, SB, SPl, SDec	12–16	>140
Spruce–poor–thrifty	231	21, 24, 25, 26	S, SB, SPl, SDec	< 12	35-140
Spruce–poor–old	232	21, 24, 25, 26	S, SB, SPl, SDec	<12	>140
Pine–good–thrifty	311	28, 30, 31	Pl, PlS, PlDec	> 19	35-140
Pine–good–old	312	28, 30, 31	Pl, PlS, PlDec	> 19	>140
Pine–medium–thrifty	321	28, 30, 31	Pl, PlS, PlDec	15–19	35-140
Pine–medium–old	322	28, 30, 31	Pl, PlS, PlDec	15–19	>140
Pine–poor–thrifty	331	28, 30, 31	Pl, PlS, PlDec	< 15	35-140
Pine–poor–old	332	28, 30, 31	Pl, PlS, PlDec	< 15	>140
	Regenerated stands				
Balsam–good–existing	113	18,19,20	Balsam leading	> 14	6-34
Balsam–med–existing	123	18,19,20	Balsam leading	11–14	6-34
Balsam–poor–existing	133	18,19,20	Balsam leading	< 11	6-34
Spruce–good–existing	213	21, 24, 25, 26	Spruce leading	> 16	6-34
Spruce–med–existing	223	21, 24, 25, 26	Spruce leading	12–16	6-34
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Pine–med–future	324	28, 30, 31	Pine leading	15–19	1-5
Pine–poor–future	334	28, 30, 31	Pine leading	< 15	1-5

[a] Inventory site index used to delineate stands into analysis units. Site index adjustments then applied to pine leading stands

Analysis unit legend: 1st digit = species group (balsam=1; spruce=2; pine=3)
2nd digit = productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing managed = 3, future managed=4).

A.2 Zone and Analysis Unit Definitions

Data source and comments:

Inventory type groups (assigned by the Ministry of Sustainable Resource Management, Terrestrial Information Branch) denote the dominant tree species as well as other species present.

Analysis units were delineated using inventory site index. The site index of lodgepole pine (*Pinus contorta spp. latifolia* [Engel.] for managed stands (current and future) was then adjusted in accordance with the findings of the publication, *The Effects of Stocking on Estimated Site Index in the Morice, Lakes and Vanderhoof Timber Supply Areas in Central British Columbia*.

The following equations apply to managed pine stands in the Morice TSA, as per page 16 of the above noted publication:

1) SBSdk sites : MSI = NSI + 14.243 – 0.606*NSI (applied below NSI 20.00) and
2) SBSmc2 sites: MSI = NSI + 17.807 – 0.931*NSI (applied below NSI 19.12).
   - MSI = Managed stand site index
   - NSI = Natural stand site index (not limited to stands > 140 years of age).

Stands younger than 35 years of age, and stands harvested in the future in the analysis, use the managed stand site index value.

A.3 Definition of the Timber Harvesting Land Base

The following sections describe the criteria used to define the timber harvesting land base and are placed in the order in which the reductions were applied.

A.3.1 Land administered by the province of British Columbia

The total land base is stratified into various ownership codes. Land must be British Columbia Crown land under provincial administration for it to contribute to the land base used to determine timber supply. However, even some areas under provincial administration, such as woodlot licences, do not contribute to timber supply in this analysis. The following ownership types within the district were considered to contribute to the timber harvesting land base:

Table A-4. Ownership categories that contribute to the timber harvesting land base and other forest management objectives in the Morice TSA

Ownership and character code	Definition
61C	Provincial land for use, recreation, enjoyment of the public
62C	Provincial forest management unit
69C	Provincial miscellaneous reserves

C denotes land available for long-term integrated resource management.

A.3.2 Woodlot licences and agricultural leases

Ordinarily, ownership and character code '77N' is used to identify areas in woodlot licenses however, the Morice Forest District provided additional woodlot mapping for use in the timber supply analysis (see Table A-1., "Inventory information"). This woodlot mapping information was used in addition to the outdated forest cover ownership mapping to remove areas within woodlots from the timber harvesting land base. The total area in woodlots is 18 935 hectares of which approximately 5928 hectares was removed through ownership codes and 13 007 hectares was removed by use of the additional woodlot mapping (in_wdlot = YES).

The AAC attributable to these areas is not included in the assessment of the current AAC for the Morice TSA. At the time the Morice timber supply analysis was undertaken, the total volume allocated to woodlot licences was 38 883 cubic metres per year. A total of 14 185 cubic metres per year in allocated woodlot volume was accounted for in TSR 1 for the Morice TSA, and the 'current AAC' harvest level reflected this volume. Accordingly, the difference in volume (24 698 cubic metres per year) has been attributed to additional woodlot licences in this analysis. This woodlot licence volume has been deducted from the total AAC of the Morice TSA, resulting in the current harvest level used in the analysis.

The ownership codes representing agricultural leases were not considered current. District staff provided information on agricultural leases as a separate map layer (ALR). The area in agricultural leases (ALR='88') was removed and totalled 21 130 hectares.

A.3 Definition of the Timber Harvesting Land Base

A.3.3 Land classified as non-forest or non-productive forest

Alpine, lakes, rock, etc., represented by inventory type identities 6 and 8, in addition to all areas within the Alpine Tundra biogeoclimatic zone were excluded from the timber harvesting land base.

A.3.4 Recreation areas

Recreation areas with high environmental sensitivity (coded as Er1) and areas identified from the recreation inventory as being of very high recreation value (coded as A0) are entirely removed from contributing to the timber supply.

A.3.5 Environmentally sensitive areas

Some forest lands are environmentally sensitive and/or significantly valuable for other resources. These areas are identified and delineated during a forest inventory and are called environmentally sensitive areas (ESAs). Table A-5. lists the types of ESAs where the area is either partially or wholly removed from the timber harvesting land base. Any areas within ESAs with a history of logging remain in the timber harvesting land base.

Table A-5. Per cent of environmentally sensitive areas considered unavailable for harvesting

ESA category	ESA description	Reduction per cent (%)
Er1	See Section 3.4, "Recreation Areas"	N/A
Es1	Sensitive soils	100
Ep1	Areas where forest regeneration is difficult	100
Ea1	Avalanche areas	100
Ew1	Sensitive wildlife areas	100
Es2	Sensitive soils — high elevation, flat, wet sites	20

A.3.6 Inoperable areas

Few harvest blocks occur above 1360-metres (4000') in elevation. Areas above 1360 metres have been identified in a non-standard layer (coded as OPERABILITY) and are removed from the timber harvesting land base. Areas associated with the standard inoperable layer (coded as IN_OP) are removed from the timber harvesting land base as well.

A.3.7 Non-commercial cover

Inventory type identity 5 represents areas currently occupied by non-commercial brush species. These areas are considered unlikely sites for timber production and were excluded from the area available for timber harvesting.

A.3.8 Non-merchantable forest types

Non-merchantable forest types are stands that are physically operable but not utilized in the Morice TSA. In the Morice TSA these types are excluded from the timber harvesting land base. The non-merchantable forest types for the Morice TSA are as shown in Table A-6.

Note: Young managed stands without inventory attributes are identified as inventory type group = 9 on the inventory file. Logged stands must be assigned an inventory type group from history records before applying non-merchantable forest type criteria (see Section A.4.6, Silviculture attributes of young stands).

A.3 Definition of the Timber Harvesting Land Base

Table A-6. Non-merchantable forest types excluded from the Morice TSA timber harvesting land base

Existing species	Inventory type group code	Per cent reduction (%)
Fir	1-8	100
Cedar	9[a]-11	100
Hemlock	12-17	100
Spruce/fir	22	100
Spruce/hemlock	23	100
Western white pine	27	100
Lodgepole pine/fir	29	100
Yellow pine	32	100
Larch	33-34	100
Deciduous	35-42	100

Note: Virtually all non-merchantable stands are found in hemlock and deciduous leading stands.

(a) Young managed stands without inventory attributes are identified as inventory type group (ITG) = 9, to avoid removing these stands from the timber harvesting land base history records or other silvicultural information must be used to identify these stands prior to applying non-merchantable forest type criteria.

A.3.9 Sites with low timber growing potential

Stands that are not likely to be harvested at maturity, based on site productivity estimates, are excluded from the timber harvesting land base (see Table A-7.). To define minimum site productivity requirements, Forest Development Plan information was used to examine the productivity of stands harvested in the recent past, or proposed for harvest in the next 5 to 6 years. Minimum site productivity requirements were chosen so that more than 96% of existing and proposed cutblocks would remain in the timber harvesting land base. Minimum site criteria are not applied to any areas with a history of logging.

Table A-7. Description of sites with low timber growing potential

Existing natural stands		Characteristics	
Inventory type group	Leading species	Site index (m)	Reduction (%)
18, 19, 20	Balsam	< 8.0	100
21, 24, 25, 26	Spruce	< 8.0	100
28, 30, 31	Pine	< 12.0	100

A.3.10 Riparian management areas

Stream, river, lake and wetland reserve buffer layers are available for the entire Morice District. The area identified as being within these riparian reserve zone buffers (coded as RIV_HA, STR_HA, LAKE_HA, WET_HA) is 8254 hectares at this point in the netdown, and are removed from the timber harvesting land base.

Current management practice for riparian management zones on stream classes S1 and S2 is to leave them unharvested. To account for riparian management zones (RMZ's) on S1 and S2 streams, 85% of the net area associated with RRZ's for rivers (RIV_HA) is removed from the timber harvesting land base (1028 hectares at this point in the netdown).

A.3.11 Existing roads trails and landings

Existing roads and trails have been identified spatially (coded RDLOG_HA, RDSEC_HA, RDTRL_HA) for the TSA in a non-standard layer (see Section A.1, "Inventory Information"). The area associated with the road buffers is removed from the timber harvesting land base. The area associated with future roads and trails is based on the area in existing roads and trails, per cent of TSA roaded and the per cent of the TSA in an unroaded condition. Reductions for existing and future roads are presented in Table A-8.

Table A-8. Area reduction for existing and future roads

Road class	% TSA roaded-landscape units removed	Road buffer width (metres)	Net area reduction (hectare)
Existing RTLs	**Ocular estimate**		
Secondary	70	30	425
Logging	40	10	4 743
Trails	30	5	1 045
Landings	29% timber harvesting land base harvested		3 854
Future RTLs (est)			
Secondary	30	30	182
Logging	60	10	7 115
Trail	70	5	2438
Landings	71% timber harvesting land base remaining		9 436

Existing area in landings is calculated on an ISIS report showing that about 4.2% of each cutblock is associated with roads and landings. It is estimated that, of the 4.2%, half is attributable to roads and half to landings. Therefore, landings impact [4.2% x 0.5] x 183 528 hectares (gross area associated with cutblocks) = 3854 hectares within cutblocks. The area associated with future landings is based on the existing landing reduction, per cent of TSA harvested and the per cent of the TSA yet to be harvested.

A.3 Definition of the Timber Harvesting Land Base

A.3.12 Areas unavailable for harvest due to economic constraints

Portions of the landscape units identified in Table A-9. are removed from the timber harvesting land base due to high development costs and low value of stands. In the base case, the portions of the landscape units identified in Table A-9. are removed from the timber harvesting land base. This was accomplished by removing parts of all forest cover polygons within those landscape units.

Table A-9. Areas unavailable to harvest due to high development costs

Landscape unit	Per cent (%) of timber harvesting land base not available
Troitsa	62
Sibola	74
Nanika	100
Morice Lake	50
Burnie	100

A.3.13 Deferrals

There are ten areas proposed for protection under the protected area strategy (PAS) within the TSA. They are the Burnie Lakes, Nanika-Kidprice, Telkwa Range, Atna Lake, Babine Lake sites (4 small lake shore sites), Nadina Mountain and Old Man Lake/China Nose. The base case assumes PAS official study areas are still harvestable (remain in timber harvesting land base) since final designations have not been made, but are deferred from harvest for the next 10 years.

A.4 Forest Management Assumptions

A.4.1 Utilization levels

Timber utilization levels define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species and are used in the analysis to calculate merchantable volume. Table A-10. shows the standards and licence requirements currently in place for wood utilization in the Morice TSA that were used to develop yield curves for this analysis.

Table A-10. Utilization levels

	Utilization		
Analysis unit	**Minimum dbh (cm)**	**Maximum stump height (cm)**	**Minimum top dib (cm)**
Lodgepole pine	12.5	30.0	10.0
Balsam	17.5	30.0	10.0
Spruce	17.5	30.0	10.0

A.4.2 Volume exclusions for mixed species stands

All deciduous species were excluded from the estimation of volume in coniferous-leading mixed species stands. All stands dominated by deciduous species were excluded from the timber harvesting land base (see Section A.3.8, "Non-merchantable forest types").

A.4.3 Minimum harvestable age derivation

Minimum harvestable ages provide an estimate of the minimum age a stand must reach before it can be harvested. They define the lower limit for harvesting. Harvesting may occur in stands at the minimum age requirements (for example, to maintain harvest levels for a short period of time or avoid large disruptions in harvest levels). However, most stands will not be harvested until well past the minimum timber harvestable ages because of management objectives for other resource values (e.g., requirements for the retention of older forest), the desire to maximize volume growth of stands, and objectives for a consistent flow of timber.

For this analysis, minimum harvestable ages were defined as the time required for balsam-leading stands to attain a volume of 200 cubic metres per hectare. Spruce and pine-leading stands had to attain a volume of 150 cubic metres per hectare. Table A-11. shows the minimum harvestable ages as well as the culmination ages for the analysis units used in this TSA.

A.4 Forest Management Assumptions

Table A-11. Minimum harvestable ages

Analysis unit	Analysis unit number	Culmination age (years)	Minimum harvestable age (years)
	Existing natural stands		
Balsam–good–thrifty	111	110	100
Balsam–good–old	112	130	100
Balsam–medium–thrifty	121	150	130
Balsam–medium–old	122	150	140
Balsam–poor–thrifty	131	180	190
Balsam–poor–old	132	190	190
Spruce–good–thrifty	211	110	80
Spruce–good–old	212	110	80
Spruce–medium–thrifty	221	140	100
Spruce–medium–old	222	140	100
Spruce–poor–thrifty	231	170	120
Spruce–poor–old	232	170	120
Pine–good–thrifty	311	80	60
Pine–good–old	312	70	50
Pine–medium–thrifty	321	100	70
Pine–medium–old	322	90	70
Pine–poor–thrifty	331	120	90
Pine–poor–old	332	120	90
	Regenerated stands		
Balsam–good–existing	113	100	80
Balsam–medium–existing	123	150	130
Balsam–poor–existing	133	160	150
Spruce–good–existing	213	80	50
Spruce–medium–existing	223	110	70
Spruce–poor–existing	233	260	200
Pine–good–existing	313	60	40
Pine–medium–existing	323	70	50
Pine–poor–existing	333	130	110
Balsam–good–future	114	100	80
Balsam–medium–future	124	130	110
Balsam–poor–future	134	170	160
Spruce–good–future	214	80	60
Spruce–medium–future	224	120	80
Spruce–poor–future	234	160	110
Pine–good–future	314	70	50
Pine–medium–future	324	80	50
Pine–poor–future	334	90	60

Analysis unit legend:

1st digit = species group ((balsam=1; spruce=2; pine=3)
2nd digit = productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing managed = 3, future managed = 4)

A.4.4 Harvest scheduling priorities

In the base case, the priority of a stand for harvest is based on the following criteria. Stands proposed for harvest within Forest Development Plans are given the highest harvest priority. Pine stands older than 120 years and spruce stands older than 140 years are given the second highest. When the age of stands available for harvest falls below 120 years (pine) or 140 years (spruce), remaining stands above culmination of mean annual increment age are given the third highest priority as a group. Finally if harvest still cannot be met, remaining stands above minimum harvest age are prioritized for harvest as a group.

Harvest of stands within the groups is random. This "group priority" harvest rule was created to reflect the harvesting patterns expressed in past and proposed forest development plans and is considered an improvement to using more standard harvest rules (e.g., relative oldest first).

A.4.5 Unsalvaged losses

For the first fifty years of the analysis, Table A-12. provides an estimate of average annual volume of timber on the timber harvesting land base that is damaged or killed and **not** salvaged.

Table A-12. Unsalvaged losses for the first 50 years

Cause of loss	Total loss (m^3/year)	Annual unsalvaged loss (m^3/year)
Fire	24 500	11 000
Wind	15 000	8 000
Mountain pine beetle Average over 5 years	150 660	68 846
Spruce bark beetle Based on 2000 overview flight	946 687	30 310
Balsam bark beetle	63 703	63 703
Total		**181 859**[a]

(a) Total unsalvaged losses of 171 959 cubic metres per year was mistakenly used in the base case (for the first 50 years). A sensitivity analysis was performed using unsalvaged losses of 181 859 cubic metres per year and indicated no impact relative to the base case.

After fifty years of the analysis, Table A-13. provides an estimate of average annual volume of timber on the timber harvesting land base that is damaged or killed and not salvaged. Losses to bark beetles drops from 162 859 cubic metres per year to 89 572 cubic metres per year due to the reduced susceptibility of younger managed stands.
case.

A.4 Forest Management Assumptions

Table A-13. Unsalvaged losses after 50 years

Cause of loss	Total loss m^3/year	Annual unsalvaged loss (m^3/year)
Fire	24 500	11 000
Wind	7 000	4 000
Insects		89 572
Total		**104 572**

The unsalvaged losses are treated as a harvest, but not reported, in all forecasts in the timber supply analysis (i.e., forecasts are net of unsalvaged losses).

A.4 Forest Management Assumptions

A.4.6 Silviculture attributes of young stands

Inventory attributes have not been updated in the inventory for harvested stands in the Morice TSA. As a result, young stands with a history of disturbance remain identified as not sufficiently re-stocked (NSR, coded as typid_prj = 4 or 9), regardless of regeneration status, and a meaningless inventory type group = 9 (cedar) which does not occur in the Morice TSA.

In order to add inventory attributes to young stands, history file information was used to determine which of these stands were logged, what species was planted and the likely age of the stand (1998 – age of disturbance – regeneration delay). The history record species and stand age were then added where missing, appropriate ITGs assigned and typid_prj reassigned to 1.

The remaining NSR was considered "real NSR" for the purpose of the analysis. NSR was also created through the updating of forest cover using forest development plan information. See Section 4.9, "Not sufficiently restocked (NSR) areas" for further details.

A.4.7 Basic silviculture and regeneration assumptions

The silviculture program guides the mix of treatments to be carried out in the Morice TSA. It is assumed that basic silviculture is undertaken on all sites, plus incremental silviculture on some sites. Table A-14. shows the proportion of each analysis unit to be treated under each silviculture regime and the expected average regeneration delay.

Existing stands older than 34 years were assigned to VDYP curves initially, then assigned to TIPSY managed stand yield curves following their first harvest in the simulation. For example, a stand currently in AU 111 would regenerate to AU 114 following harvest, as indicated in Table A-14. Growth in existing plantations (stands between 6 and 34 years of age) and future plantations (stands less then 6 years and all future stands harvested by FSSIM) were projected using managed stand yield tables (MSYTs) produced using the B.C. Forest Service table interpolation program for stand yields (TIPSY) growth and yield model (batch version).

A.4 Forest Management Assumptions

Table A-14. Regeneration assumptions by analysis unit

Existing analysis units	Regeneration analysis units	Species composition	Regen[a] delay (years)	OAFs[b] (%)		Method		Species[c]		Initial density stems/ha
				1	2	Type	%	Code	%	
111,112,113,121,122, 123,131,132, 133	114,124,134	Balsam leading	2	15	5	Plant	100	S8P2	16	1500
111,112,113,121,122, 123,131,132, 133	114,124,134	Balsam leading	2	15	5	Plant	100	S5P5	23	1500
111,112,113,121,122, 123,131,132, 133	114,124,134	Balsam leading	2	15	5	Plant	100	P8S2	61	1500
211,212,213,221,222, 223,231,232,233	214,224,234	Spruce leading	2	15	5	Plant	100	S8P2	10	1500
211,212,213,221,222, 223,231,232,233	214,224,234	Spruce leading	2	15	5	Plant	100	S5P5	55	1500
211,212,213,221,222, 223,231,232,233	214,224,234	Spruce leading	2	15	5	Plant	100	P8S2	35	1500
311,312,313,321,322, 323,331,332,333	314,324,334	Pine leading	2	15	5	Plant	100	P8S2	49	1500
311,312,321,322, 331,332	313,323,333	Pine leading	2	15	5	Plant	100	P5S5	51	1500

Analysis unit legend:

1st digit = species group ((balsam=1; spruce=2; pine=3)
2nd digit = productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing managed = 3, future managed = 3).

(a) Regeneration delay.

(b) Operational adjustment factors (OAFs) are used to adjust timber yield estimates to account for operational conditions.

(c) S8P2 denotes spruce regeneration 80% of the time and pine regeneration 20% of the time.

Data source and comments:

Future managed spruce stands have a 2.4% genetic gain modelled in the base case (in mixed stands, gain applied only to spruce component).

The species composition column in Table A-14. refers to the leading species of the existing natural stands before harvest and regeneration.

The species column in Table A-14. refers to the regeneration species, per cent and proportion. Yield curves were generated for each of the two or three regimes denoted for each leading species and prorated together based on proportion.

Balsam-leading stands are being regenerated to:

- a pine-leading stand (Pli80Sx20) 61% of the time;
- a mix of pine and spruce (Pli50Sx50) 23% of the time; and
- a spruce-leading stand (Sx80Pli20) 16% of the time.

Spruce-leading stands are being regenerated to:

- a spruce/pine mix (Sx50Pli50) 55% of the time;
- a spruce-leading (Sx80Pli20) 10% of the time; and
- a pine-leading stand (Pli80Sx20) 35% of the time.

Pine-leading stands are being planted to:

- a pine/spruce (Pli50Sx50) 51% of the time; and
- a pine-leading (Pli80Sx20) 49% of the time.

A.4.8 Immature plantation history

If necessary, all stands currently less than 35 years old have received density control treatments and are considered managed stands. Immature stands are split into existing (6 to 34 years) and future (less then 6 years and stands harvested in the analysis) managed stands.

A.4.9 Not satisfactorily restocked (NSR) areas

Identification of NSR stands cannot be made directly from the Morice TSA forest cover file due to two complicating factors.

1) Regenerated stand attributes are not updated to reflect current status.

   Many young regenerated stands still remain identified as NSR (coded as typid_pr = 4 or 9) due to the lack of inventory updates for these stands. Before "real NSR" can be determined, inventory attributes need to be assigned to young stands using history records (see Section A.4.6, "Silviculture attributes of young stand" for further details).

2) Forest cover needs updating for disturbance.

   Some mapsheets have not been updated for disturbance. In order to bring disturbance up-to-date, existing cutblocks identified in Forest Development Plans were used to update disturbance. Mature stands identified as being within existing cutblocks were re-classed as NSR and assigned an age of –2 to reflect regeneration delay.

A summary of what remains after young stands are removed from NSR status and newly logged areas are added is provided here. Total NSR area in the timber harvesting land base is estimated at 22 524 hectares. Backlog NSR is estimated at 5595 hectares and will be reforested within 10 years. All current NSR will be restocked within two years. NSR is restocked to current managed stand proportions within each biogeoclimatic zone, and leading species combination. All NSR stands are assigned a leading species and corresponding analysis unit of medium productivity. Table A-15. outlines the amount of backlog and current NSR by species for the Morice TSA.

A.4 Forest Management Assumptions

Table A-15. Not satisfactorily restocked (NSR) areas

Leading species	Total NSR (hectares)	Current NSR (hectares)	Backlog NSR treated	Backlog NSR not treated
Balsam	3 196	2 998	118	80
Spruce	5 603	4 343	665	596
Pine	13 725	9 589	2 194	1 942
Total	22 524	16 930	2 977	2 618

A.4.10 Forest cover requirements

The timber supply model used (FSSIM Version 4.1a) can incorporate forest cover requirements that specify both the maximum proportion of an area allowed in a disturbed condition, and the minimum required area of old-age forest. As noted in Section A.2.1, "Management zones (groups)," forest cover requirements were applied to model management for a number of objectives. Where a management group (e.g., retention VQO) spans more than one landscape unit, the forest cover requirements were modelled at the landscape unit level.

A.4.10.1 Forest cover requirements — landscape-level biodiversity

Only the old-seral guidelines were modelled in the base case, consistent with the assumptions used in the February, 1996 *Forest Practices Code Timber Supply Analysis*. As biodiversity emphases had not yet been approved for landscape units in the Morice TSA, an average old-seral prescription was applied to each landscape unit. This average prescription was calculated assuming a distribution of area between biodiversity emphases of 45% low-biodiversity, 45% intermediate-biodiversity and 10% high-biodiversity. The per cent area of old-seral forest to be maintained over time under each biodiversity-emphasis is based on values from the *Forest Practices Code Landscape Unit Planning Guide* for each of the biogeoclimatic variants in the Morice TSA. In addition, old-seral targets for the low emphasis portion of the old-seral constraint have been reduced to one-third the *Planning Guide* value for the first rotation (0 to 70 years), two-thirds of the target for the second rotation (71 to 140 years), and the full target value for the remainder of the planning horizon (141 years onward). The final old-seral requirements calculated using this method for each landscape unit/variant combination are shown in Table A-16.

A.4 Forest Management Assumptions

Table A-16. Old-seral requirements by biogeoclimatic variant.

Biogeoclimatic unit	NDT type	Old-seral requirement (%) starting in year			Age (years)	Land base to which constraints apply
		1	70	140		
AT	5	N/A	N/A	N/A	N/A	N/A
CWHws2	2	6.7	8.1	9.4	> 250	Crown forested
ESSF mc	2	6.7	8.1	9.4	> 250	Crown forested
ESSF mk	2	6.7	8.1	9.4	> 250	Crown forested
ESSFmv3	2	6.7	8.1	9.4	> 250	Crown forested
MH mm2	1	14.2	17.1	19.9	> 250	Crown forested
SBS dk	3	8.2	9.9	11.5	> 140	Crown forested
SBS mc2	3	8.2	9.9	11.5	> 140	Crown forested
SBS wk3	3	8.2	9.9	11.5	> 140	Crown forested

A.4 Forest Management Assumptions

Sensitivity analyses evaluating the impact of using the draft biodiversity emphasis options were also performed.

Table A-17. Draft biodiversity emphasis options by draft landscape unit

Landscape unit	Biodiversity emphasis option
Buck	Low
Burnie	N/A[a]
Fulton	Low
Gospel	Intermediate
Grapnels	Low
Houston – Tommy	High
Kidprice	Intermediate
Morice Lake	High
Morrison	Intermediate
Nadina	Intermediate
Nanika	N/A[a]
North Babine	Low
Owen	Intermediate
Parrots	Low
Sibola	High
That's	Low
That'll	High
Toccata/Nitwit	Intermediate
Topple	Low
Troitsa	High
Valley	Intermediate
Whitehall	Intermediate

(a) Burnie and Nanika have no timber harvesting land base.

A.4.10.2 Forest cover requirements — resource emphasis areas

All forest cover requirements were modelled at the landscape unit level. Where forest cover requirements are expressed using a height criterion, the age at which regenerated stands achieve this height was estimated using *SiteTools batch 3.1a*. Then the ages were area-weighted by resource emphasis area (zone or group) and landscape unit. (For example, the age at which stands within the integrated resource management areas of the Buck landscape unit achieve 3 metres top height (green-up height) averaged 17 years.)

Table A-18. Forest cover requirements — base case

Zone or group	Maximum allowable disturbance (% area)	Green-up height (m)	Minimum retained area (%)	Minimum age or height for retention	Source of prescription and land to which contributes
Zone 'A', Morice LRUP	1	3			Timber harvesting land base Morice LRUP allows entry to address forest health issues
Visually quality class 1 (preservation)	1	5			Crown forested area for all recommended VQC' polygons
Visually quality class 2 (retention)	5	5			Crown forested area for all recommended VQC polygons
Visually quality class 3 (partial retention)	15	5			Crown forested area for all recommended VQC polygons
Visually quality class 4 & 5 (modification / max-modification)	25	5			Crown forested area for all recommended VQC polygons
Telkwa Caribou Herd recovery program (key forested features)	25	3	25%[a] of timber harvesting land base in ESSF and SBS Telkwa Caribou area	> 90 years	Timber harvesting land base
IRM area	25	3			Timber harvesting land base

(a) District staff approximate that 50% of the area within the ESSF and SBS Telkwa caribou herd recovery area is high quality caribou habitat (key forested features), and thus the forest cover requirement of 50% > 90 years for high quality habitat has been modified to 25% of the timber harvesting land base > 90 years.

A.4.11 Wildlife tree and wildlife tree patches (WTP's)

This analysis revealed that based on the *Landscape Unit Planning Guide* criteria (Table A3.1 page 95), the district average WTP requirement (where draft landscape unit boundaries have been proposed) is 7.25%. Consistent with assumptions used in the February, 1996 *Forest Practices Code Timber Supply Analysis*, one half of the area is assumed to come from the timber harvesting land base. As a result, the area retained TSA-wide for WTP's is 7.25% of which 3.6% was assumed to come from the timber harvesting land base. The analysis assumes that WTP's are not large enough to contribute to old-seral requirements and WTP's are not likely not to be harvested in the future due to succession, potential forest health losses and windthrow concerns over the next rotation. A WTP reduction of 3.6% is applied to all yield curves by FSSIM in the timber supply analysis.

A.5 Volume Estimates for Existing Stands

The variable density yield projection (VDYP) model, version 6.5a developed and supported by the Ministry of Sustainable Resource Management, Terrestrial Information Branch, was used to estimate timber volumes for existing natural stands. Table A-19. shows the volume estimates by analysis unit for existing natural stands.

The volumes shown in Tables A-19. were reduced by a further 3.6% when the timber supply model was run to account for the impact of wildlife trees retained in all cutblocks in the Morice TSA. See Section A.4.11, "Wildlife tree and Wildlife tree patches (WTP's)" for more details.

Table A-19. Timber volume tables for existing natural stands (cubic metres/hectare)

	Analysis units (existing stands)								
Age (years)	**111**	**112**	**121**	**122**	**131**	**132**	**211**	**212**	**221**
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	5	1	0	0	0	0	0	0	0
40	31	21	5	4	0	0	8	6	0
50	68	54	24	22	5	4	49	44	5
60	105	88	51	46	18	17	100	96	33
70	141	123	82	76	38	37	147	143	73
80	172	152	106	100	57	55	189	184	110
90	200	178	129	122	74	72	225	220	144
100	225	202	150	142	90	88	256	250	175
110	249	224	170	161	105	103	283	277	203
120	271	245	189	179	119	117	307	300	228
130	293	267	208	197	134	131	329	321	252
140	314	287	226	214	147	145	347	339	272
150	334	305	243	230	160	158	362	355	290
160	352	322	258	246	173	170	375	368	304
170	368	339	273	260	184	182	386	379	317
180	384	354	287	274	196	193	394	388	328
190	399	368	300	287	206	204	402	396	337
200	413	382	313	299	217	215	409	404	346
210	427	395	325	311	227	225	415	411	354
220	440	408	337	323	236	235	421	417	362
230	452	420	348	335	246	245	427	422	369
240	465	432	359	345	255	254	431	427	375
250	476	443	370	356	264	263	436	432	381
260	478	445	372	358	265	264	439	435	385
270	480	447	374	360	267	265	442	438	389
280	482	449	376	361	268	267	444	440	393
290	483	450	377	363	269	268	446	442	396
300	485	452	379	364	270	269	448	444	399
310	486	453	380	365	271	269	450	446	402
320	488	455	382	367	272	270	452	447	404
330	489	456	383	368	273	271	453	449	406
340	490	457	384	369	274	272	454	450	408
350	491	459	385	370	275	273	455	451	410

Analysis unit legend:
1st digit = species group ((balsam=1; spruce=2; pine=3);
2nd digit = productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing managed = 3, future managed=4).

(continued)

A.5 Volume Estimates for Existing Stands

Table A-19. Timber volume tables for existing natural stands (cubic metres/hectare) (concluded)

	Analysis units (existing stands)								
Age (years)	**222**	**231**	**232**	**311**	**312**	**321**	**322**	**331**	**332**
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	1	0	0	0	0
30	0	0	0	36	44	6	7	1	2
40	0	0	0	95	107	50	53	15	15
50	4	0	0	147	161	94	97	50	51
60	29	2	2	192	208	133	137	83	84
70	69	17	14	231	248	167	172	113	114
80	107	45	39	266	283	199	203	140	140
90	141	75	69	296	314	227	231	165	165
100	172	103	97	324	343	253	257	188	188
110	199	130	124	350	368	277	280	209	208
120	224	154	148	373	391	299	302	229	228
130	248	177	172	395	414	320	322	248	246
140	269	198	194	410	428	334	336	261	259
150	286	217	213	421	440	345	347	272	270
160	302	234	230	429	448	352	355	280	278
170	315	248	245	433	453	357	361	285	284
180	327	261	259	435	455	359	363	288	287
190	337	273	271	433	454	358	363	288	288
200	347	284	283	435	456	360	366	290	291
210	356	294	294	437	459	363	369	293	294
220	364	304	304	440	462	366	372	296	297
230	371	313	314	443	465	368	375	299	300
240	378	321	322	445	468	371	377	302	303
250	384	329	330	448	471	373	380	304	306
260	389	334	336	450	473	376	382	306	308
270	393	340	342	452	475	378	384	308	310
280	397	345	347	454	477	379	386	310	312
290	400	349	351	456	479	381	388	311	313
300	403	353	356	457	481	383	389	313	315
310	406	357	360	459	482	384	391	314	316
320	409	360	363	460	484	385	392	315	317
330	411	363	366	462	485	386	393	316	318
340	413	366	369	463	486	387	394	317	319
350	415	368	372	464	487	388	395	317	319

Analysis unit legend:
1st digit = species group ((balsam=1; spruce=2; pine=3);
2nd digit = productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing managed = 3, future managed=4).

A.6 Volume Estimates for Regenerated Stands

The Table Interpolation Program for Stand Yields (TIPSY) batch version 3.1 a, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. Existing managed stands were assumed to be all stands with an age of 6 to 34 years and future managed stands represent stands less then 6 years and all stands harvested and regenerated in the analysis. The area-weighted site index for each analysis unit along with the regeneration assumptions shown in Table A-14. were used as inputs to Batch TIPSY.

The volumes shown in Table A-20. were reduced by a further 3.6% when the timber supply model was run to account for the impact of wildlife trees retained in all cutblocks in the Morice TSA. Table A-20. displays the volume tables for managed stands.

A.6 Volume Estimates for Regenerated Stands

Table A-20. Projected volumes for managed stands using TIPSY (cubic metres/hectare)

Age (years)	Analysis units (managed stands)								
	113	114	123	124	133	134	213	214	223
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	1	0	0
30	8	8	0	1	0	0	27	17	3
40	41	38	1	6	1	1	94	69	20
50	92	89	11	23	5	3	174	141	59
60	149	144	28	50	14	12	246	209	112
70	200	195	53	87	33	25	306	266	162
80	245	238	84	124	56	45	356	318	207
90	283	277	115	159	83	69	393	358	245
100	318	311	144	188	109	94	420	386	283
110	342	337	170	214	134	119	441	410	313
120	361	356	193	239	157	141	459	428	336
130	376	372	212	261	177	161	470	442	353
140	390	383	232	280	194	179	480	454	367
150	400	396	249	294	212	196	482	463	378
160	408	402	265	307	228	212	485	469	388
170	416	412	277	318	243	227	486	470	397
180	421	416	287	326	255	239	486	471	403
190	426	421	295	333	264	250	486	472	409
200	428	426	302	340	272	259	486	473	413
210	430	426	309	345	280	267	486	472	417
220	430	427	314	349	285	273	486	471	419
230	430	427	318	352	291	278	486	471	420
240	431	426	322	353	296	283	486	471	419
250	433	428	325	357	300	287	486	471	419
260	431	428	328	358	303	291	486	471	420
270	429	427	328	357	306	293	486	471	419
280	429	425	330	358	307	297	486	471	416
290	427	426	333	359	308	299	486	471	415
300	427	426	333	359	308	299	486	471	415
310	427	426	333	359	308	299	486	471	415
320	427	426	333	359	308	299	486	471	415
330	427	426	333	359	308	299	486	471	415
340	427	426	333	359	308	299	486	471	415
350	427	426	333	359	308	299	486	471	415

Analysis unit legend:
1st digit = species group ((balsam=1; spruce=2; pine=3);
2nd digit = productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing managed = 3, future managed=4).

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-20. Projected volumes for managed stands using TIPSY (cubic metres/hectare) (concluded)

	Analysis units (managed stands)								
Age (years)	**224**	**233**	**234**	**313**	**314**	**323**	**324**	**333**	**334**
10	0	0	0	0	0	0	0	0	0
20	0	0	0	5	6	2	1	0	1
30	1	0	0	67	58	42	33	0	22
40	12	0	0	153	145	114	99	2	73
50	39	0	5	227	225	182	171	16	140
60	83	0	15	288	294	238	236	39	200
70	128	1	34	334	348	287	289	62	250
80	173	3	62	369	393	323	335	89	296
90	211	7	92	399	424	350	370	113	334
100	243	13	122	421	448	374	394	134	360
110	275	22	151	441	467	393	416	154	383
120	302	37	174	456	478	409	432	170	400
130	323	51	195	464	486	420	446	186	414
140	339	67	216	469	489	431	457	198	425
150	352	83	236	472	489	440	464	210	434
160	361	99	253	476	489	449	469	219	442
170	371	115	267	476	489	449	469	229	448
180	378	128	279	476	489	450	471	237	453
190	384	140	289	476	489	453	471	242	455
200	389	153	298	476	489	452	473	248	457
210	393	164	304	476	489	453	472	253	456
220	397	175	311	476	489	454	472	256	453
230	399	186	317	476	489	455	472	260	453
240	401	196	320	476	489	454	472	262	452
250	400	204	324	476	489	454	472	266	451
260	400	213	327	476	489	454	472	268	449
270	401	220	330	476	489	454	472	268	448
280	400	225	333	476	489	454	472	271	447
290	400	230	332	476	489	454	472	273	444
300	400	230	332	476	489	454	472	273	444
310	400	230	332	476	489	454	472	273	444
320	400	230	332	476	489	454	472	273	444
330	400	230	332	476	489	454	472	273	444
340	400	230	332	476	489	454	472	273	444
350	400	230	332	476	489	454	472	273	444

Analysis unit legend:
1st digit = species group ((balsam=1; spruce=2; pine=3);
2nd digit = productivity rating (G=1; M=2; P=3);
3rd digit = stand class (thrifty = 1; old = 2; existing managed = 3, future managed=4).

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis portion of this report identifies employment and income impacts, changes in government revenues, and community impacts as a result of changes in the TSA's harvest levels over time. Some of the assumptions used in this report are as follows:

- **Employment multiplier** — employment multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. The calculation of employment multipliers is based on analytical assumptions and data collected at a specific time period. The multipliers reflect industry and employment conditions at that time and may not accurately reflect industry and employment conditions in the future.
- **Employment coefficient** — employment coefficients are ratios of person-years of employment per 1000 cubic metres of timber harvested. These ratios are used to estimate employment levels associated with alternative harvest rates. This method of analysis assumes that the industry structure will be the same in the future as it is today. While reasonably accurate in the short term, employment coefficients may change in the future due to changes in market conditions, product mix or production technologies.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While this assumption is reasonably accurate for the harvesting sub-sector, employment estimates for the silviculture and timber processing sub-sectors may not be as coincidental. As well, indirect and induced impacts tend to occur over a longer period, as levels of business and consumer spending adjust to changes in harvest levels.
- **Operating thresholds of mills** — it is unlikely that impacts on timber processing employment due to changes in harvest levels will be in direct proportion to the harvest changes (i.e., a 10% change in harvest may not lead to a 10% change in timber processing employment). Impacts on timber processing employment are more likely to occur step-wise related to operating thresholds of mills. For example, if a mill's timber supply is reduced, its operating threshold is reached when the decrease in timber supply causes it to lay off a shift of workers or to close the mill, either temporarily or permanently. Conversely, if the timber supply to the mill is increased, a processing threshold is reached when the mill has to decide whether to add another shift of workers or new capacity to process the increase in timber supply. In both cases, the per cent change in employment in the mill would probably differ from the per cent change in the timber processed. Because mills have many different operating configurations, accurately predicting an individual mill's operating threshold is impossible. As a result, impact figures pertaining to employment in timber processing are best interpreted as size of change rather than as precise changes in employment levels.
- **Government expenditures** — provincial government expenditures are more related to government policy and population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite changes to the harvest level and subsequent changes in government revenues from the forestry sector. However, provincial government expenditures would likely change if a community's population significantly changes. This would amplify the community impacts of losses or gains in forestry sector jobs.
- **Proportional harvest reductions** — harvest reductions are assumed to be proportionately distributed among all licensees and all forms of tenure within the TSA.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from BC STATS, the Ministry of Finance, Statistics Canada and local communities. Estimates of taxes paid by the forest industry are from PriceWaterhouseCoopers.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1. harvesting;
2. silviculture; and
3. timber processing.

Employment and income impacts were estimated in several steps. The first step was to assess current activity in each of the three sub-sectors. Then, indirect and induced employment and employment income impacts were estimated, using data from Ministry of Finance (1996) and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log salvage, planning and administration functions and log transportation. The employment multipliers used in this analysis define activities such as road building or maintenance work as indirect employment rather than direct employment because the forestry sector and other basic sectors purchase these services.

Data on employment, place of residence and timber flows were obtained from responses to questionnaires that were sent to licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of residents *versus* non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1. TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2. Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

B.2 Economic Impact Analysis Methodology

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part time during the year. Because of this, information on silviculture employment was converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was pro-rated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber supply is from the harvest of the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest. Employment figures were also adjusted to reflect the residences of workers (i.e., those who lived within the TSA and those who lived outside the TSA). Employment in timber processing that is supported by chip by-products from milling operations was also similarly estimated.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly engaged in the basic forestry sector (for example, those who build or maintain road for log transport). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance.

Two sets of employment multipliers were calculated for this report: a migration multiplier and a no-migration multiplier. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that displaced workers remain in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

B.2 Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Morice TSA analysis are shown in Table B-1.

Table B-1. Employment multipliers — Morice TSA

Forestry sub-sector	Morice TSA migration multiplier	Morice TSA no-migration multiplier	Provincial (interior) migration multiplier	Provincial (interior) no-migration multiplier
Harvesting	1.38	1.21	2.14	1.80
Solid wood processing	1.65	1.42	2.29	1.93
Pulp and paper	1.41	1.22	3.02	2.48

Sources: Ministry of Finance. 1999. The 1996 Forest District Tables.

Ministry of Finance. 1996. A provincial impact estimation procedure for the British Columbia forestry sector.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forestry sector workers during the period 1998 to 2000 (in 1999 dollars) was:

$47,100 for those working in logging and forestry services;

$44,900 for those working in solid wood manufacturing; and

$56,400 for those working in pulp and paper mills.

Those in indirect and induced occupations earned approximately $30,800. Income taxes were calculated based on marginal tax rates of 23 – 28% with one-third of the total income tax paid accruing to the province.

Employment estimates of alternate timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in future years. Therefore, the employment estimates should be viewed as indicators of size of change rather than as precise estimates of changes in employment levels.

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated (Table B-2.).

Table B-2. Estimates of provincial government revenues — Morice TSA

	Average annual revenue 1997-2000 ($ millions)	Revenue ($ per '000s m³)
Stumpage and related payments[a]	97.3	44,400
Forest industry taxes[b]	16.3	7,450
Employee income tax[c]	11.7	5,350
Total	125.3	57,200

(a) Source: Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers. Includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.